- Education, research and entrepreneurship cornerstones to a global enterprise
- Synergising multi-disciplinary strengths in research
- Cultivating productive global research links
- Key focus in line with Singapore's economic growth

STRATEGIC RESEARCH INITIATIVES

NUS strives for excellence in education, research and service in its aspirations to be a globally-oriented university. Strategic linkages and internationally recognised peaks of excellence bear testament to the University's success in synergising the three main thrusts and leveraging on the strengths of its faculty and broad-based capabilities.

NUS produces research of international quality and impact in a broad range of fields. To maintain its competitive edge, the university seeks to reinforce its core research infrastructure, faculty and programmes. This is achieved by identifying and developing rapidly-emerging areas and promoting multi-disciplinary research.

Biomedical and Life Sciences remains a major thrust in NUS. The Office of Life Sciences (OLS) was established in 2001 to coordinate, integrate and synergise the various life sciences teaching and research programmes at NUS and affiliated institutions. In addition, the Centre for Life Sciences, launched in 2006, provides a conducive multi-disciplinary research platform that facilitates the advancement of life sciences research.

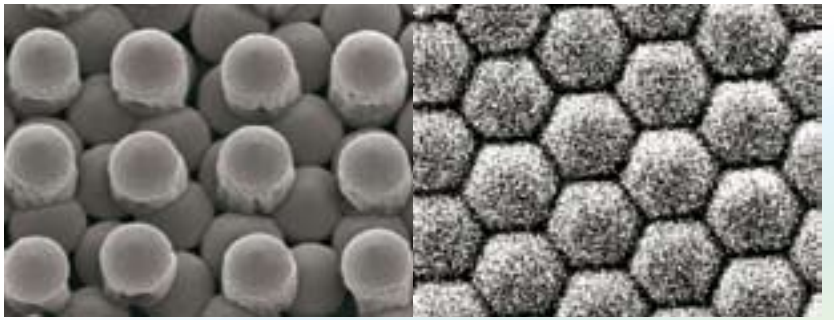
Since inception, OLS has initiated research programmes that focus on core areas including Cancer, Neurodegenerative Diseases, Cardiovascular Biology and Infectious Diseases; which are built around the platform technologies of Computational Biology, Bioengineering, Tissue Engineering, Experimental Therapeutics, Immunology and Structural Biology.

NUS has identified clinical sciences and translational medicine as emerging areas in biomedical and life sciences research.

Translational Medicine bridges basic biomedical research and healthcare for patients. In supporting this initiative, NUS has appointed Professor Edward Holmes and Professor Judith Swain, two leading physician-scientists, as Lien Ying Chow Professors of Medicine. These prestigious appointments will enhance translational research synergies between the Agency for Science, Technology and Research (A*STAR) research institutes, NUS, hospitals and disease centres in Singapore. In addition, the new Duke-NUS Graduate Medical School offers a research-intensive curriculum that will lead to the development of new doctors who can be further trained as clinician-scientists with strong research capabilities in translational medicine.

Physical Sciences and Engineering is another critical domain in NUS. Keeping abreast with industry needs and technological advancements, NUS is committed to promoting initiatives and programmes of strategic importance.

Nanoscience and Nanotechnology research is thriving in NUS. Discoveries range from a nanonickel catalyst that efficiently catalyses the reaction of water and alcohol to produce hydrogen fuel, new catalysts functionalised on nanofibre membranes to degrade chemical warfare agents, to sensitive radiation detectors. The exciting field offers endless prospects in manufacturing, defence, transportation, space and environmental applications.



Quantum Information is an emerging multi-disciplinary field that is gaining momentum in NUS and the scientific world. The NUS Quantum Information Technology group focuses on quantum cryptography, quantum computation, the interaction between light and matter, and fundamentals of quantum mechanics. NUS recently gained national recognition when the team was awarded a national science award.

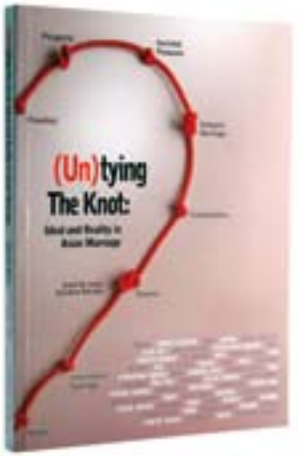
Environment and Water Technology research is becoming increasingly important. By leveraging on its comprehensive research infrastructure in engineering, science and medicine, NUS is geared towards collaborating with government agencies and industry to actively contribute to Singapore's long-term water strategy.

Interactive and Digital Media is a significant focus area. The NUS IDM Network was established to promote technological advancement and commercialisation of interactive digital media. NUS achieved a milestone when it opened the NUS Hollywood Lab. Aimed at fostering international research collaborations and technology commercialisation, the lab exemplifies NUS' strategy for the advancement of interactive and digital media.

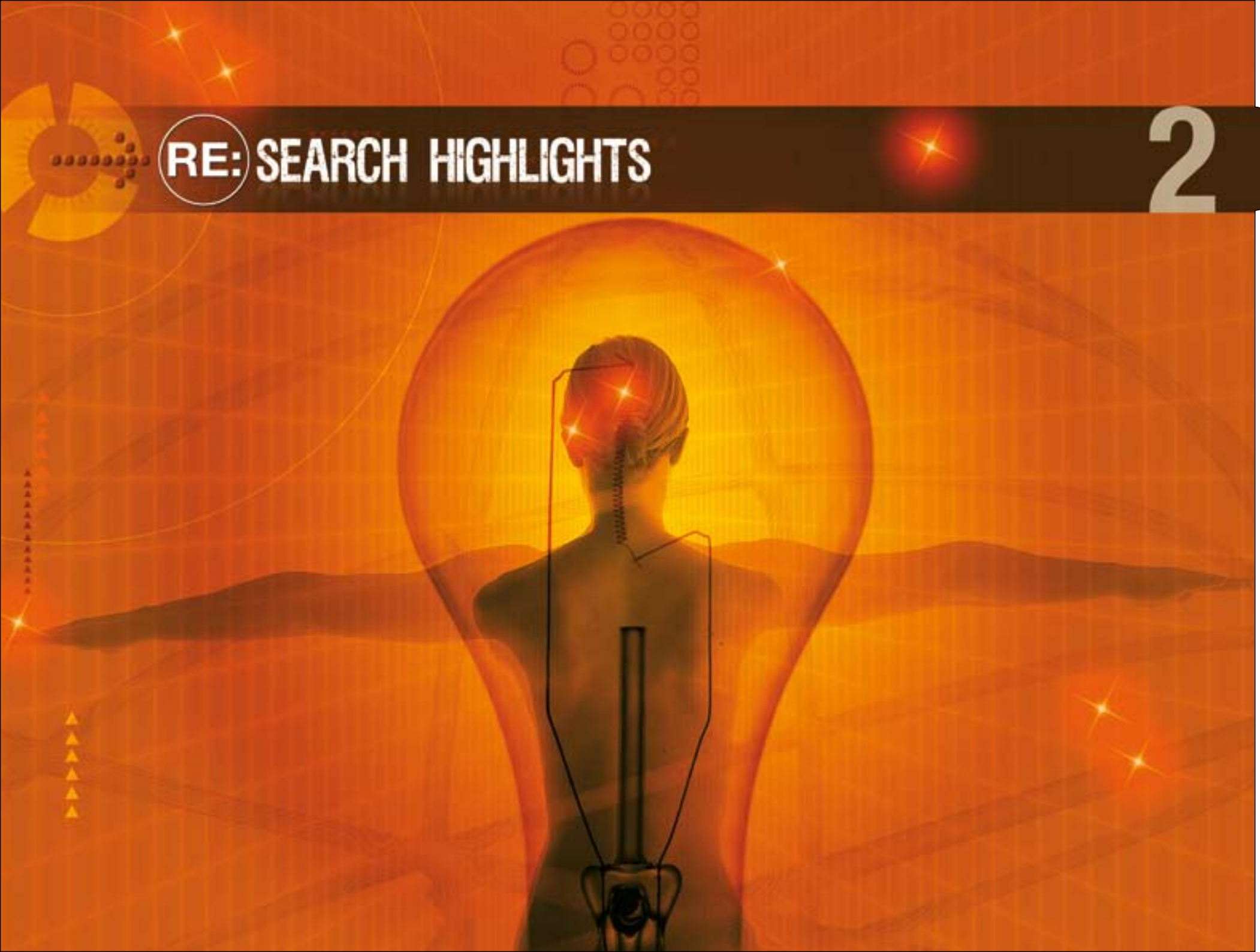
Maritime Research and Transportation, Logistics & Supply Chain Management at NUS received a boost. In 2005, NUS established the Centre for Maritime Studies to meet the demand of local and regional industry in specialised training, skill development and continuing education in maritime-related domains. In the same year, NUS, in collaboration with Lloyd's Register and the Maritime and Port Authority of Singapore, launched two professorships to kick-start maritime research in Singapore. Following this, a key research programme was initiated with Neptune Orient Lines to spearhead research in enhancing knowledge and expertise in the field of global cargo transportation and logistics.

Defence-related Research is well established in NUS. The University continues to enhance and strengthen collaborations with Singapore's Ministry of Defence and US Defense Advanced Research Projects Agency (DARPA) with intensive support from the Defence Science and Technology Agency.

Humanities and Social Sciences focus on fundamental and current social, cultural and economic issues and their implications in Asia. These include studies of economies; religion and ethnic interactions; family life; health; ageing; globalisation in Asia and its challenges; politics and policy. In addition to the promotion of these efforts by researchers in the Faculty of Arts and Social Sciences (FASS), the Asia Research Institute (ARI) maintains research clusters that study the impact of culture, family, globalisation, migration and Asian cities in collaboration with FASS and the Faculty of Law, NUS Business School and the School of Design & Environment. One example of collaboration is the Asian Marriage Research Network set up with an international consortium of multi-disciplinary researchers to undertake research on issues of marriage and divorce in the Asia-Pacific region.



By capitalising on its broad-based capabilities, talented faculty and strategic tie-ups, NUS aspires to be a key node in the global knowledge network. NUS aims to increase the impact and quality of research through its strategy of identifying and supporting strategic areas of focus, promoting multi-disciplinary programmes, and encouraging the application and commercialisation of NUS research.



- *More than 2,000* projects undertaken annually
- *Strong* research foundation for ideas and applications
- High-impact work benefiting society
- Niche strategic research areas
- Breaking new frontiers

RESEARCH HIGHLIGHTS

Assisted Reproduction Through Micromanipulation System

Piezo-assisted Intra-Cytoplasmic Sperm Injection (ICSI) for more effective fertilisation.

An inter-disciplinary team comprising researchers from the NUS **Departments of Electrical and Computer Engineering** and **Obstetrics and Gynaecology** has developed an automated micromanipulator for the ICSI procedure based on a piezo actuator for more effective sperm injection. This system is able to achieve controlled and precise motion for the pipette to inject the sperm into the egg more effectively than the human hand, with very high-resolution motion in the sub-micron or micron ranges. The same actuator can also be used to cut off the mobile sperm tail for generating the activation material used to fertilise the egg cell. The team has also designed a novel vibration profile to achieve Piezo-ICSI without the use of mercury to increase inertia of the penetration.

The team's achievement has won the Best Paper Award 2004, ASEAN Virtual Instrumentation; First Prize and Innovation Award, First Singapore Engineering Design Challenge 2005; and Top 20 Papers in BioNano 2005.

Architecture of piezo control system with microinjection workstation.

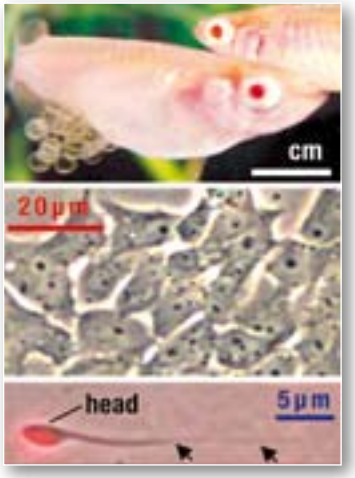
Assisted Reproduction System team.

Test-Tube Sperm

Stem cell research opens up possibilities for treatment of infertility in men.

Assoc Prof Hong Yunhan and his team at the NUS **Department of Biological Sciences** have successfully developed the non-mammalian embryonic stem cell lines from medaka, a common freshwater fish. The medaka is an excellent vertebrate model for stem cell biology because of its easy/transparent embryology and robust cell derivation. The first test-tube sperm from the fish may one day be extended to mammals and pave the way for treating infertility in men.

The finding has been published in the *Proceedings of the National Academy of Sciences* and hailed as a major breakthrough for the scientific community. Prof Hong won the University Outstanding Researcher Award in 2005 for the work.



Medaka fish (top). Its similarity in sperm production to mammals allows modelling analysis of mammalian sperm production and causes of defects in male infertility. Adult medaka spermatogonia propagate in culture (middle) and can be induced to generate test-tube sperm (bottom). This sperm undergoing maturation has a condensed head and a long tail (arrow).

Knee Cartilage Repair

Successful repair of damaged knees using stem cells.

The Therapeutic Tissue Engineering team headed by Prof Lee Eng Hin and Assoc Prof James Hui from the NUS **Department of Orthopaedic Surgery** was one of the first groups worldwide to use bone marrow-derived stem cells (BMSCs) to repair cartilage defects in humans. The researchers have identified a novel strategy for addressing clinical problems associated with skeletal abnormalities. They used mesenchymal stem cells which can differentiate into a variety of functional tissues such as bone, cartilage, adipose tissue, tendons and muscles. These cells have an advantage over embryonic stem cells in that they do not face bioethics issues and the risk of generating tumours.

The team achieved a breakthrough in clinical trials when they successfully repaired the knees of five patients in 2005. Both researchers have won numerous awards for their work.

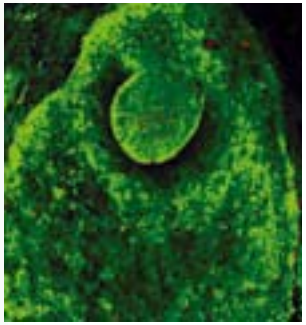
Production of Bone Cells from Embryonic Stem Cells

Potential for transplantation therapy and drug or biomaterial screening.

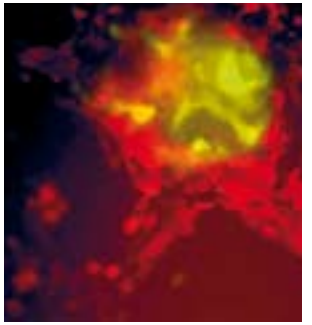
Human embryonic stem cells (hESC) offer tremendous potential for the development into specialised cells for transplantation. They can also be used for broad-ranging therapeutic and non-therapeutic purposes such as gene/protein delivery therapy, drug discovery, environmental analysis and toxicity screening tests.

The Stem Cell Group at the NUS **Faculty of Dentistry** is among the few groups in the world to successfully cultivate cartilage, bone and blood vessel cells from hESC. The team headed by Dr Cao Tong scored a first when they achieved *in vitro* differentiation of hESC into cartilage cells. Their model system efficiently studied direct differentiation of hESC towards cartilage cells, and demonstrated the full process of chondrogenesis. By using a different approach of not dissociating the cells from embryoid bodies prior to differentiation, the researchers allowed osteogenic differentiation to take place within intact and adherent embryoid bodies. Enzymatic dissociation is detrimental because it destroys inter-cellular contact crucial for cell viability and differentiation potential.

The team was also the first to report on the study of successful hESC endothelial differentiation and its use in animal therapeutic application, while their published work of the differentiation of bone cells from hESC was the third in the world, and the first in Asia.



Osteogenic nodule structure with hESC-derived bone cells with FDA (green) and PI (red) stained under confocal laser microscope.



Bone-specific Alkaline Phosphatase fluorescent (red) stained hESC-derived bone cells and STRO-1 fluorescent (yellow-green) stained hESC-derived mesenchymal precursor cells.

Surgical implantation of Osteosheet for restoring the eye orbit. More than 30 patients have been successfully treated.

Bioresorbable Mesh for Craniofacial Surgery

Engineer-clinician team uses advanced biomaterials, computer-aided design system and rapid manufacturing to create implants for craniofacial surgery.

The US Food and Drug Administration Agency has granted approval for Singapore-developed scaffolds to be used in craniofacial surgery, a first for the country in medical implant devices. The new implants replace the more expensive titanium version used in covering up holes in the skull left by surgery and non-bioresorbable polymers such as silicone rubber and polyethylene used in craniofacial surgery. The biodegradable bone devices allow the patient's own tissue to regenerate and have been used successfully in more than 160 patients undergoing reconstructive surgery for head injuries.

The biomaterials work was led by Prof Teoh Swee Hin from the NUS Centre for Biomedical Materials Applications and Technology, **Department of Mechanical Engineering**. The team includes researchers from NUS **Division of Bioengineering**, the National University Hospital and Temasek Polytechnic.

The team has patented the process of fabricating the scaffold, and filed another two patents for products design. The invention won the gold award of the 2004 Asian Innovation Awards. Osteopore International Pte Ltd has been spun-off to manufacture, obtain regulatory approval and sell the products.

Bioengineering Ocular Tissue-Equivalents

Study results in composite graft tissue that may be transplanted back to the eye to replace damaged corneal or conjunctival epithelium.

Pioneering work in stem cell research and ocular surface transplantation of the eye has positioned Singapore as the top centre in the world for conjunctival tissue-engineering and transplantation, and a leading centre for corneal and ocular surface stem cell research and disease treatment. Dr Leonard Ang from the NUS **Department of Ophthalmology** is improving the understanding of the biology of ocular surface stem cells, the clinical application of stem cells by expansion and transplantation, and bioengineering ocular tissue-equivalents for the treatment of ocular surface disorders. His team has managed to harvest stem cells from the donor eye without damage, grow them and expand them into graft tissues that may be transplanted back to the eye to replace damaged corneal or conjunctiva. The use of autologous cells minimises the risk of infection and eliminates graft rejection. Tissue obtained from living-related donors may also be used.

Besides treating many blinding eye diseases where conventional methods have limited success, the technology will alleviate problems of donor tissue shortage and rejection.

Origins of Atherosclerosis and Neurodegeneration

Effects of metals on atherosclerosis demonstrated through nuclear microscopy and other technologies.

Diet-induced atherosclerosis, or plaque build-up on vessel walls, is associated with iron accumulation and zinc depletion in the affected areas, on top of greatly increased oxidative damage to cholesterol and other lipids.

A team of investigators at the NUS **Yong Loo Lin School of Medicine**, led by Prof Barry Halliwell from the NUS Department of Biochemistry, discovered that the iron chelating agent desferrioxamine delays the development of lesions. They also showed that increasing the zinc content in rabbits' diet markedly inhibited free radical damage and atherosclerosis. This suggests that zinc has powerful anti-atherosclerotic effects. The findings have led to a trial on the effect of zinc on lipid peroxidation in humans. The work has been published in *Free Radical Biology and Medicine*.

Nuclear microscopy studies by the group also revealed that association of iron ions with amyloid plaques may contribute to oxidative damage in Alzheimer's disease. This technology provides a novel method of identifying such plaques in the brain without staining.

Nucleation — Processes Behind Daily Phenomena

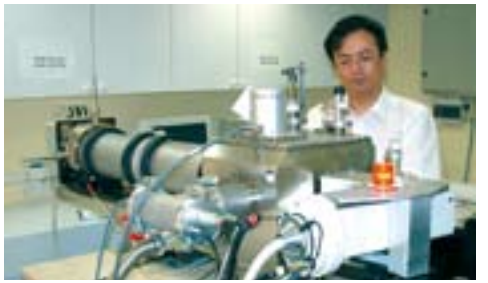
Further understanding of nucleation cornerstone for important modern technologies, including life/nano sciences and engineering.

Nucleation phenomenon, a process taking place at the nano or sub-nano scale, is one of the most important aspects in our daily life. Its importance ranges from the condensation and freezing of water, bone formation, to semiconductor and IT processing technology. This can be explained in terms of the correlation between its microstructure and superior properties. However, nucleation is still poorly understood and disputed and no quantitative experimental evidence exists to verify current theories.

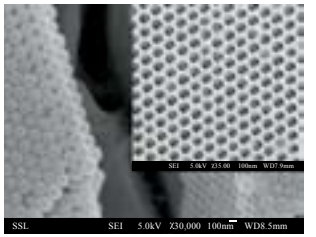
Assoc Prof Liu Xiang Yang and his group in the NUS **Department of Physics** have achieved a first by conducting *in situ* observations and direct imaging of the nucleation process of charged colloidal particles. The kinetics of nucleation was measured and correlated to nucleation theories quantitatively and accurately for the first time. This verification will lead to new breakthroughs spanning materials, IT and life sciences technologies.

The team has developed technology to produce novel supramolecular functional materials based on the new understanding of the formation mechanism of the nanostructures of supramolecular functional materials. Two international patents have been granted.

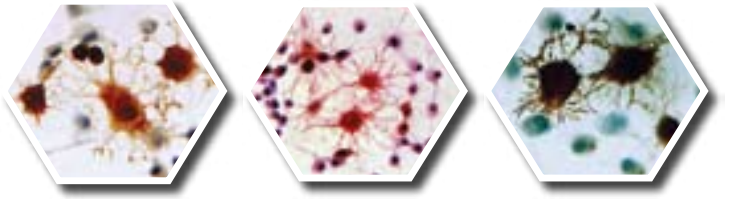
Nucleation of colloidal spheres (polystyrene particles) under an alternating electric field.



Assoc Prof Liu Xiang Yang working at a small angle X-ray scattering machine that categorises nanostructure.



Colloidal crystals as 3-D template. They can be used to fabricate optical switches, optical transistors and filters. Inset: High-quality inverse opal–photonic crystal. The diameter of the colloidal particles is 1μm.



Juxtanodin alters the cell shape and facilitates process outgrowth and branching of cultured oligodendrocytes.

Novel Neural Protein

Discovery of new protein paves way for treatment of neurological disorders.

A novel protein of the nervous system christened "Juxtanodin" has been identified by a team of researchers led by Dr Liang Fengyi from the NUS **Department of Anatomy**. Group members include Prof Ling Eng-Ang from the same department and Dr Low Boon Chuan from the NUS **Department of Biological Sciences**.

Juxtanodin speeds up the development of oligodendroglia, which are responsible for the formation of myelin involved in brain signalling process. Abnormalities in the oligodendroglia can result in miscommunication and disorders in the nervous system.

The first in the world to characterise Juxtanodin's functions, the researchers paved the way for developing more effective ways of treating neurological disorders such as multiple sclerosis and schizophrenia. The work will also shed light on brain ageing and neurodegeneration or regeneration. The findings were published in the *Proceedings of the National Academy of Sciences*, US.

RUNX3 Biology, Novel Tumour Suppressor

Study suggests mechanism by which nuclear translocation of RUNX3 is regulated.

RUNX3 is a gene considered to be inactivated in about 50 percent of gastric cancer cases primarily by the silencing of the gene by promoter hypermethylation. In a breakthrough study published in *Cancer Research*, a team in the **NUS Cancer Programme** headed by Adjunct Prof Yoshiaki Ito found that RUNX3 is localised in the cytoplasm and not in the nucleus where the transcription factor functions. This means RUNX3 is not functioning in about 80 percent of gastric cancer. The high degree of inactivation, rarely seen in any cancer, is supported by reports from many laboratories. It suggests that RUNX3 is involved in many types of cancer, highlighting the gene's importance as a cause of human cancer.

By clarifying the mechanism by which nuclear translocation of RUNX3 is regulated, the team may be able to design a method to screen drugs for therapeutic purposes, since the RUNX3 gene make-up is mostly intact when it is inactivated in cancer.

Dark Soya Sauce Fights Free Radicals

Isolating compounds responsible for antioxidant effects possible for treatment of diseases and production of healthier foods and supplements.

Prof Barry Halliwell from the NUS **Department of Biochemistry** found that dark soya sauce was about 150 times more potent than vitamin C as an antioxidant, and 6 to 12 times better than red wine. It also increases blood flow, with the potential to prevent stroke. His findings have been published in *Biochemical and Biophysical Research Communications*.

His research team is determining the constituents in the sauce responsible for the antioxidant effect. Besides their potential as chronic disease treatment, the compounds can be used in the food processing industry as a healthier preservative, in anti-ageing products and as a health supplement.

Snake Venom Offers Therapeutic Possibilities

Peptides from venom show pro-coagulant property.

Prof Jeyaseelan Kandiah from the NUS **Department of Biochemistry**, together with colleagues at the NUS **Departments of Biological Sciences** and **Pharmacology**, has discovered peptides from snake venom with treatment potential.

The group isolated four new phospholipases with pro-coagulant activity from the venom of an Australian snake, *Pseudonaja textilis*. For the first time, the researchers showed that two genes could produce two different isoforms of phospholipases via RNA editing. The DNA and protein sequences have been deposited in the public database at the National Centre for Biotechnology Information at the US National Institutes of Health *(www.ncbi.nlm.nih.gov)*.

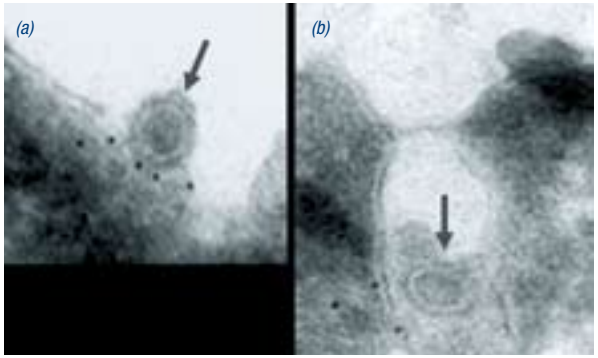
Australian Common Brown Snake, Pseudonaja textilis.

Virus Entry Knowledge Gives Hope to Mosquito-Borne Disease

Research brings scientists closer to finding drug to treat flaviviruses.

Assoc Prof Mary Ng and Dr Justin Chu Jang-Hann from the NUS **Department of Microbiology** achieved a world's first when they discovered how the mosquito-borne West Nile virus enters the human body. The discovery brings scientists closer to finding a drug to treat not only this virus, but also other mosquito-borne diseases. Currently there is no commercial vaccine or antiviral against flaviviruses. The team aims to design an effective and safe antiviral compound, vaccine or strategy against West Nile virus infection and other flaviviruses, such as dengue viruses and Japanese encephalitis.

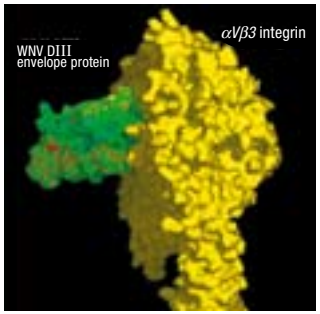
The discovery has been patented and published in international journals such as the *Journal of Biological Chemistry* and *Journal of Virology*. The team intends to collaborate with a pharmaceutical company to develop antiviral drugs against mosquito-borne viruses.



West Nile virus entering the cell.

(a) West Nile virus (arrow) is seen attaching to the cellular receptor αVβ3 integrin (labelled with gold particles) at the cell surface.

(b) The virus particle (arrow) is internalised into the cells through clathrin-mediated endocytosis. The clathrin molecule is labelled with gold particles.



A computer-generated model showing the good fit of the Domain III protein with the αVβ3 integrin molecule.

Sediment and Biogeochemical Fluxes in Tropical Forest Catchments

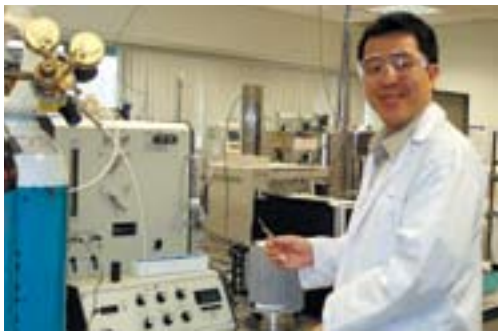
Findings vital for evaluating impact of forest management practices on erosion and the role of sediment in biogeochemical cycles, most notably carbon.

Concerns about climate change have led to much attention on carbon fluxes but the role that streams and rivers play in mobilising and transporting particulate carbon remains poorly understood. Some of the research projects developed in the NUS **Department of Geography** by Assoc Prof David Laurence Higgitt involve detecting the impacts of environmental change on the transfer of water, sediment and carbon in several large river systems of Southeast Asia. In Singapore, the focus is on hydrological processes in forested headwaters. The first task of the project has been to re-establish an experimental catchment in the remnant primary forest within Bukit Timah Nature Reserve. The monitoring programme will enable the sediment and particulate carbon flux to be quantified and related to hydrological conditions. The second aim is to develop a proof-of-concept for the use of environmental radionuclides such as Cs-137, Pb-210 and Be-7 as indicators of soil erosion in tropical forests and to develop models of sediment delivery derived from radionuclide "fingerprints".

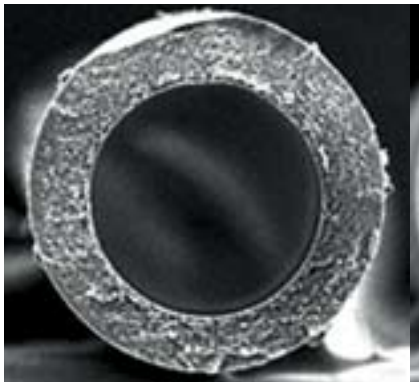
Nanocatalyst for High-Performance Clean Fuel

Oil shortage and increasing pollution spur research in technologies that produce and deliver hydrogen fuel economically in an environment-friendly way.

A team of researchers, led by Assoc Prof Sibudjing Kawi from the NUS **Department of Chemical and Biomolecular Engineering** has discovered a highly active and selective nanonickel/or rare-earth-oxide catalyst that can efficiently catalyse water and alcohol, such as ethanol produced from biomass, to produce hydrogen fuel. The team successfully developed this nanocatalyst into a novel catalytic hollow fibre membrane which can perform simultaneous catalytic production and separation of ultra-pure hydrogen from alcohol. With this technology, future "green" cars can produce enough hydrogen on-board with a simple mixture of alcohol and water.



Assoc Prof Sibudjing Kawi leads team to produce hydrogen more efficiently and economically for cars of the future.



Desirable sponge-like structure with high flux and selectivity.

Undesirable structure full of finger-like macrovoids.

Enhancing Nanofibres for Membrane Bioreactors

Characterisation and modification of nanoporous flexible hollow fibres for membrane bioreactors, critical components used in water treatment and other environmental applications.

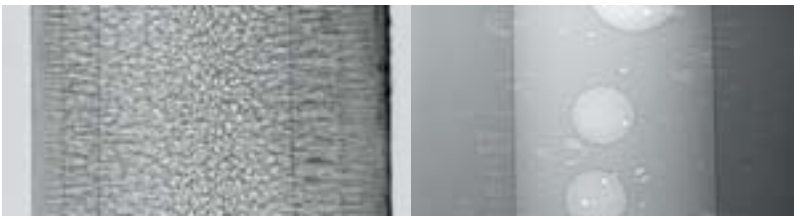
Prof Neal Chung Tai-Shung from NUS **Department of Chemical and Biomolecular Engineering** is working with Hyflux Ltd, a water purification and fluid treatment company, to understand the science and engineering of membrane formation. The joint research also seeks to characterise Hyflux ultra-filtration membranes for water treatment and recycling. The team combines the knowledge and experience of Hyflux on membrane engineering and system design, and the strengths and capabilities of NUS on polymers and polymer processes.

Technological breakthroughs have been made on the understanding of macrovoid formation and how to make hollow fibre membranes with higher permeability and separation factor. Macrovoids or finger-like voids are usually considered undesirable because they weaken the structural integrity of a membrane and make it more susceptible to compaction and mechanical failure. Hyflux has developed macrovoid-free ultra-filtration membranes with superior performance, while NUS has provided the science and advanced characterisation tools to explain the mechanisms and superior separation performance.

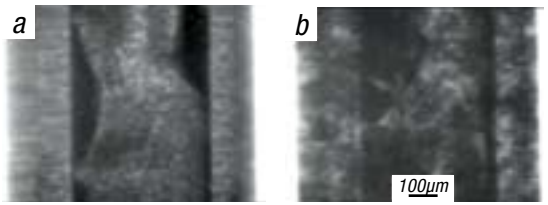
Non-Invasive Observation of Membrane Filtration

First high-resolution microimaging of live internal membrane filtration phenomena.

Scientists from Singapore and Australia have achieved a world-first in allowing the observation of non-invasive live membrane filtration at a hitherto unavailable spatial resolution of 1µm. Led by Prof Anthony Fane from the University of New South Wales, the team comprising researchers from the **Singapore Synchrotron Light Source**, Nanyang Technological University and Institute of Environmental Science and Engineering developed a new X-ray microimaging approach based on refractive contrast. As the X-rays go through the capillaries in polymer membrane, the pores of the membrane, the deposition and removal of pollutants, and flow phenomena such as bubbles can be examined non-destructively. The technique allows the viewing of filtration in a natural setting and has the potential for studying real-time fouling phenomena with a membrane at a higher level of resolution than other non-invasive methods. This has implication for future research in membrane filtration properties.



Dry (left) and water-filled (right) membrane capillaries. Image about 1mm wide. In the dry membrane, pores are imaged. When filled with water, bubbles can be observed which could not be seen with absorptive contrast.



Filtration of ferric hydroxide particles in water in the size range of 0.1–2µm showing the progressive (from a to b) deposition of smaller particles in the pores and of cake on the inner wall surface.

Prof Seeram Ramakrishna holding nanofibres that can be used to detoxify poisonous agents.

The membrane (right) can be used in the canister of face masks to remove toxic agents.

Nanomaterials Against Toxic Agents

Electrospun membranes capture and detoxify chemical and biological warfare agents.

A group headed by Prof Seeram Ramakrishna at the **NUS Nanoscience and Nanotechnology Initiative** has developed new catalysts that degrade chemical warfare agents more efficiently than the present activated charcoal system. These catalysts can be functionalised on nanofibre membranes fabricated by the team's patented electrospinning technique. The nanofibre membrane has properties that make it lighter and allow good moisture transport, thus is suitable for garments and face masks. The material, which is being patented, has great potential for protection from chemical and biowarfare agents. It can also be used in other industrial applications.

Synthetic Architecture for Fabricating Nanomaterials

Breakthrough concept for self-generation curved architectures from building blocks.

One of the major technological challenges in nanoscience and nanotechnology is the self-assembly of small nanobuilding units into larger organised conformations and geometrical architectures for device applications. Generation of curved architectures is a particularly major problem. To address this challenge, Assoc Prof Zeng Hua Chun from the NUS **Department of Chemical and Biomolecular Engineering** has introduced the "synthetic architecture" concept into fabrication and organisation of nanomaterials. His team devised a new organisation scheme for self-generation of curved architectures from building blocks formed *in situ*. First, nanoribbons of cupric oxide (CuO) form rhombic crystal strips spontaneously and these CuO units then self-assemble into dandelion-like architectures with hollow interiors. In contrast to previous methods, this novel hierarchical organising scheme relies primarily on geometric constrains of building blocks through a chemical process.

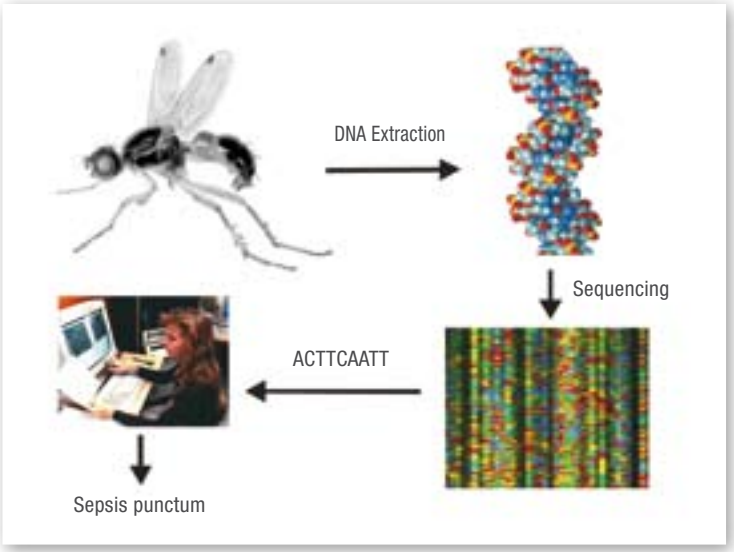
This breakthrough concept has led to many publications in leading chemical and materials journals, with good response by the nanoresearch community. The work is ranked No. 1 in citation among 1,215 research articles published on this material over 2004 to 2006.

DNA Barcoding and Taxonomy in Diptera

Study shows high intraspecific variability and low success in species identification.

DNA barcodes and DNA taxonomy have invited debate when discussed in major journals as the future approach to taxonomy. At the heart of the controversy are the claims that DNA sequences can provide reliable species identification and that they can be used to identify species boundaries.

Mr Kwong Shiyang and Mr Guarav Vaidya, both students from the NUS **Department of Biological Sciences**, have demonstrated that the identification success based on DNA sequences was below 70 percent. Mr Kwong who is also with the **University Scholars Programme** and Mr Vaidya, under the guidance of their department supervisors Assoc Prof Rudolf Meier and Assoc Prof Peter K L Ng, conducted their investigation using a data set comprising 1,333 cytochrome c oxidase I (COI) sequences for 458 species of *Diptera*, which includes flies, gnats and mosquitoes. They also showed that due to the fact that pair-wise distances between three sequences are rarely equidistant, it is impossible to build a logically consistent sequence-based taxonomy. The finding has been accepted for publication by the journal *Systematic Biology*.



Identifying species using DNA.

Knowledge-Based Decision-Support System

Verified as useful analytical tool for evaluation, control and management of variations during design and construction.

Some 290 schools in Singapore are currently being upgraded or rebuilt under the Programme for Rebuilding and Improving Existing Schools (PRIME) at an estimated cost of S$4.46 billion. Time and cost overruns in PRIME would mean severe repercussions for the school sector, thus it is crucial to understand the causes, effects and controls for variations.

The joint research project between the Singapore Ministry of Education (MOE) and NUS focuses on the development of a knowledge-based decision support system (KBDSS) for managing variation orders. Led by Prof Low Sui Pheng from the NUS **Department of Building**, the KBDSS helps decision-makers select the appropriate controlling methods as well as anticipate potential variation orders during the initial phase such that correct measures can be taken.

With modifications, the study can be expanded to the management and control of variation orders in upgrading, rebuilding or new building projects. The research project won the 2005 Donald S Barrie Award from the Project Management Institute in the US.

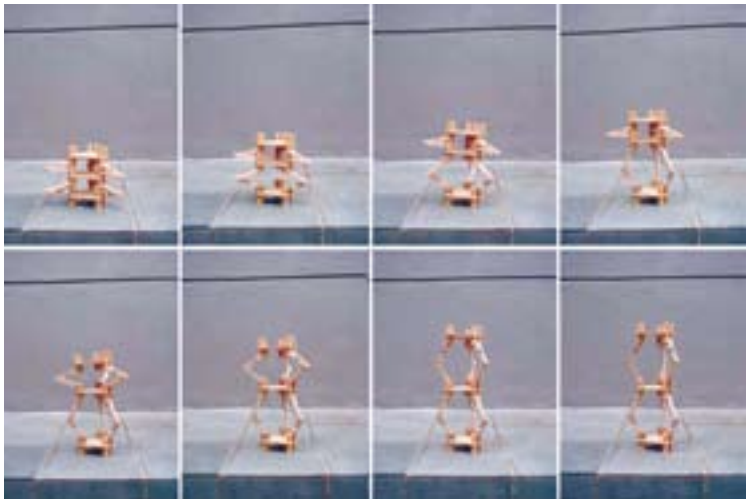
The KBDSS team: (from left) Mr Winston Wee (Development Management Executive, MOE), Mr Eng Wee Tong (MOE collaborator), Mr Faisal Manzoor Arain (NUS researcher) and Prof Low Sui Pheng (principal investigator).

Deployable Tension-Strut Structures

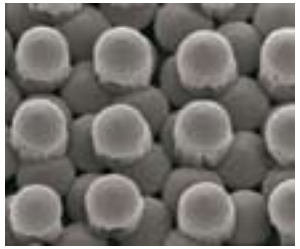
Development will offer rapidity, safety and economy in construction.

Deployable Tension-Strut Structures (DTSS) developed at the NUS **Department of Civil Engineering** have been used in a range of fields such as exhibitions, emergency services and military services. Headed by Assoc Prof Richard Liew, the DTSS efforts started in 2003 and evolved into a full-scale model by the end of 2005, with a patent application.

The research team has engineered a procedure for further mechanical study and exhaustive design of DTSS to create a wide variety of geometric forms. Analytical studies on structural properties of DTSS will provide an insight into the structural behaviour of DTSS and show how DTSS can be proportioned for structural efficiency. Along with these analyses, a new structural analysis theory using commutative algebra was proposed, winning the IASS Hangai prize in 2005. A boom prototype designed has the exciting potential to be developed into a space station or docking port for shuttle vehicles.

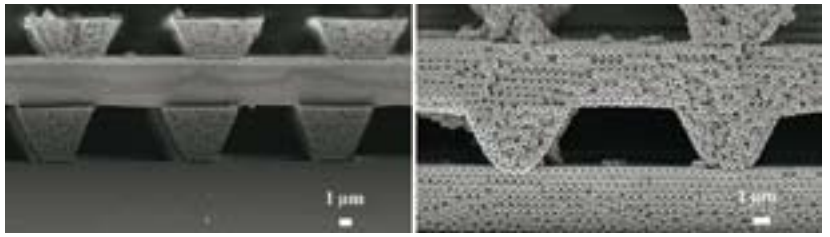


Deployable tension-strut structures.



An approach to creation of line and point defects embedded in the interior of a self-assembled photonic crystal. Photoresist patterns are first constructed on the surface of a silica opal film with conventional optical photolithography. After regrowth of the silica colloidal crystal, photoresist line defects are introduced into the self-assembled silica colloidal crystal. Further processing results in an inverse opal with air-core line defects embedded in its interior, providing a prototype of future optical waveguide devices based on self-assembled 3-D photonic crystals.

Source: Advanced Materials 2005, Vol. 17, pp.1917–20.



SEM images of a 3-layer (left) and 4-layer (right) colloidal woodpile structure.

Source: Langmuir 2006, Vol. 22, pp. 7001–06.

Self-Assembling 3-D Photonic Structures

Nanolithography meets self assembly for fabricating photonic crystals with desired defects.

Photonics, the technology of moulding light flow, is expected to outperform current electronic technology. The key to photonics is the fabrication of photonic crystals, which are periodic dielectric structures with lattice parameters comparable to the wavelength of light. Assoc Prof George XS Zhao and colleagues from the NUS **Departments of Chemical and Biomolecular Engineering** and **Electrical and Computer Engineering**, and **NUS Nanoscience and Nanotechnology Initiative** have designed a fresh approach to fabricating photonic crystal functional devices and nanostructures by combining self-assembly with nanolithography. It cleverly integrates "bottom-up" with "top-down" materials processing techniques.

The simple and cost-effective method can fabricate defects in a 3-D photonic crystal, allowing the material to be used as an optical device. For instance, line defects embedded in a 3-D photonic crystal can function as a waveguide.

The work, published in numerous top journals including *Advanced Materials*, *Advanced Functional Materials*, *Chemistry of Materials* and *Journal of Materials Chemistry* has received wide recognition by *Nature Nanotechnology*, Materials Research Society, American Chemical Society, etc. It was among the Top 10 most downloaded article ranked by the Royal Society of Chemistry.

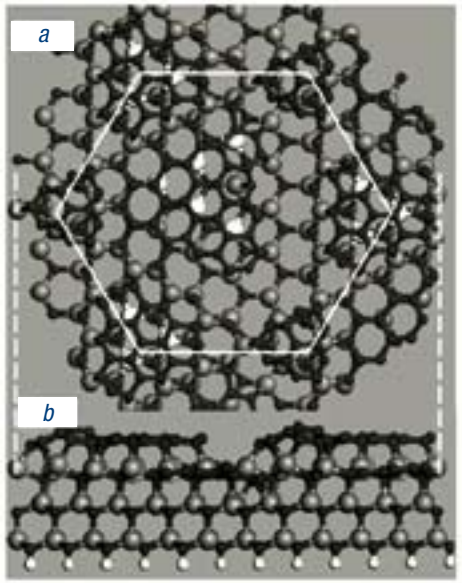
Revealing the Carbon Nanomesh Structure on Silicon Carbide

Fabrication of 2-D self-assembled nanotemplates.

A team from the NUS **Departments of Physics** and **Chemistry** headed by Prof Andrew Wee has fabricated 2-D self-assembled nanotemplates. These templates have sites that accommodate individual nanostructures favouring the formation of well-ordered nanometre-sized functional arrays.

The group used highly surface-sensitive X-ray photoemisson spectroscopy at the **Singapore Synchrotron Light Source** and scanning tunnelling microscopy to determine the atomic structure of the carbon nanomesh formed on silicon carbide 6H–SiC(0001). The scientists observed two different carbon nanomesh-related carbon components. They proposed that the carbon nanomesh template arose from the self-organisation of excess carbon atoms, which formed a novel honeycomb arrangement on top the 6H–SiC(0001) surface after annealing at 1400˚K.

This nanotemplate has promising potential for well-ordered 2-D arrays of nanostructures.



(a) Top view and (b) side view of the 6x6 model.

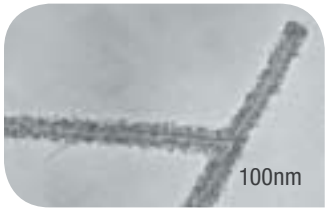
The small dark spheres represent carbon atoms, the big grey spheres stand for silicon atoms, big white spheres for silicon atoms with dangling bonds, and the small white spheres for hydrogen atoms. The white hexagon highlights the honeycomb unit cell in the scanning tunnelling microscopy images.

Nanostructured Conducting Polymers

Quest for smaller electronic components in sub-10nm regime as alternatives to silicon technology.

A team headed by Prof Hardy Chan in the NUS **Department of Chemistry** has succeeded in making nanostructures using conducting polymers. These nanorods and nanotube Y-shaped junctions are potentially-important building blocks in molecular electronics, connecting different sizes of nanostructures to each other. The team prepared a stable Fe_3O_4 nanotemplate, and the magnetic Fe_3O_4 nanoparticles self-assemble to form chains on which aniline polymerises. By controlling the pH of the reaction, solid polymer nanorods or hollow nanotubes can be produced. This work was chosen as one of the "Hot Articles" by *Chemistry of Materials* and a research highlight in *Chemistry World*.

Polyaniline Y-junction nanorod.



Polyaniline Y-junction hollow nanotube.

Thermal Conduction in Nonlinear Lattices

Theory that chaos plays an essential role in the onset of macroscopic transport processes and hence in the origin of irreversible behaviour overturned.

Findings by Assoc Prof Li Baowen from the NUS **Department of Physics** suggested that microscopic chaos has no direct connection with irreversible behaviour. The researcher introduced several identification systems in which the Lyapunov exponents were discovered to be zero, demonstrating no chaos.

The results from computer simulations of heat transportation in his model showed that heat conduction obeys Fourier's Law of heat conduction only in the disordered channels. Both findings shed new light on the microscopic origin of irreversible macroscopic phenomena, a connection physicists hope to establish. The understanding of the heat conduction process can lead to the development of new materials to control heat flow with significant implications for the environment. The results have been published in top journals such as *Physical Review Letters* and widely cited.

Thermal Dehydration R&D

Inter- and multi-disciplinary research to develop new and innovative concepts for industrial dryers.

Thermal dehydration is an energy-intensive operation encountered in almost every industrial sector. It is responsible for 10 to 20 percent of national industrial energy consumption in developed countries and costs billions of dollars annually in some industrial sectors. With little R&D effort devoted to understanding the fundamentals of the complex heat and mass transfer phenomena and their coupling with the quality of the dried products, innovation in industrial drying has been very slow.

Prof Arun Mujumdar from the NUS **Department of Mechanical Engineering**, recognised worldwide as the "Drying Guru", has initiated a global effort to establish drying as a multi- and inter-disciplinary R&D programme. His focus on developing new and innovative concepts for industrial dryers via mathematical models and experimental validations has made important contributions to pulse combustion drying, novel design concepts for spray drying, superheated steam drying and heat-pump assisted drying. He has received numerous awards for his work and earned special recognition for "Global Leadership in Drying R&D" at the Asia-Pacific Drying Conference in 2005.

Prof Arun Mujumdar with the multi-mode heat pump dryer in the background.

Nanoexplosion Creates Electronic Nanodevices

AFM helps induce conductivity in insulating polymer.

Nanolithography based on atomic force microscopy (AFM) offers a unique and versatile tool for nanoscale patterning and device fabrication. A team headed by Prof Andrew Wee at the **NUS Nanoscience and Nanotechnology Initiative** has exploited this instrument to create nanostructures on poly (N-vinyl carbazole) (PVK) by AFM-induced nanoscale explosion, a first in the world. PVK reacts with oxidative particles generated in the nanoexplosion to produce raised structures that show distinct chemical and physical characteristics. The originally insulating PVK matrix is converted to chemically modified conducting patterns and has potential application in fabricating electronic nanodevices.

The new technique can be extended to many other materials such as metals and semiconductors. The findings have been published in *Journal of the American Chemical Society*.

Nanoelectronic IMOS

Development of world-record sub-threshold swing for integrated circuits.

A team at the NUS **Department of Electrical and Computer Engineering** Nano Device Laboratory led by Dr Yeo Yee Chia has joined forces with the Singapore Institute of Microelectronics to develop a highly scalable transistor structure with a significant boost in speed. The new technology breakthrough enables a transistor with a sub-threshold on/off swing of only 4.5 millivolts per decade, a gigantic leap in technology given today's mainstream device of an average 60–80mV.

In addition, researchers at the department have also designed the world's smallest ionisation metal oxide semiconductor (IMOS) part of gate length of 60 nanometres. Savings in power consumption would lead to efficient energy usage and longer operating time per battery charge for mobile electronics. The team has filed patents for device designs, structures and methods of manufacture.

Micro-TPV Power Generator Yield Higher Efficiency

Applications of novel system cover a wide range of micromechanical and electronic devices.

Micro-thermophotovoltaic power (TPV) generator is a new concept of power microelectromechanical systems (MEMS) initiated at the NUS **Department of Mechanical Engineering**. A team led by Prof S K Chou has made a prototype of a novel micro-TPV power generator, which is able to deliver an electrical power output of 3 Watt in a package the size of a mobile phone battery. The efficiency of the system is higher than other micro-power generators being developed around the world. They have filed a patent for the invention in the US. More than 10 papers have been published in international journals such as *Applied Physics Letters* and *Journal of Applied Physics*.

Top right: Micro-TPV cell array with enhanced cooling fins attached.

Right: Research engineer testing the prototype micro-TPV power generator.

Predicting Interior Electromagnetic Scattering of Air Intake

Methods modelling electromagnetic scattering comparable to best in the world.

Temasek Laboratories@NUS (TL@NUS) has developed several methods to model electromagnetic (EM) scattering from the interior structure of air intake. These include Higher Order Finite Element - Boundary Integral (FEBI) method; and the Field Iterative Method (FIM). The Higher Order FEBI algorithm is currently one of the most versatile and efficient algorithms to study the interior scattering from a complex air intake. Headed by Mr Gan Yeow Beng, the researchers designed an algorithm that is comparable to the state-of-the-art method developed by Prof Jin Jianming from the University of Illinois at Urbana-Champaign. The FIM is a highly efficient algorithm for large air intake created by Prof Gary Thiele from the University of Dayton, Dayton, Ohio, US. TL@NUS has collaborated with Prof Thiele to resolve some key problems found in the original algorithm and has made significant improvements to the FIM. The team is one of the leading groups in the computational EM community on the modelling of large air intake structure.

Control and Guidance Design Tools

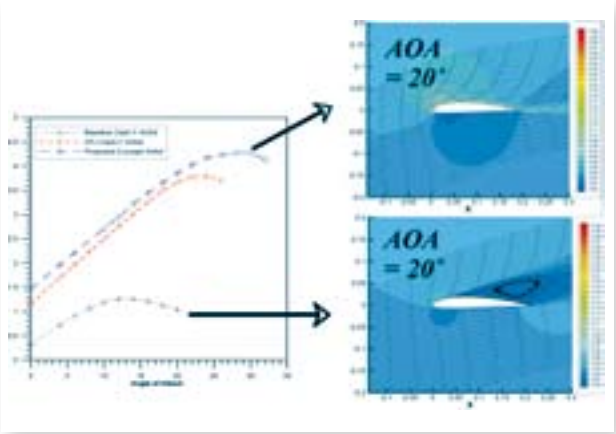
Suite for dynamic output feedback and sensor faults deployed in DSO National Labs development project.

Temasek Laboratories@NUS has extended its fault-tolerant linear flight control research to the dynamic output feedback setting, as well as sensor faults. A team led by Dr Lum Kai Yew has developed a full suite of design tools as part of the research, which was applied in a DSO National Laboratories platform development project. Design and simulation jointly conducted with DSO has demonstrated the practical potential of the work. In addition, fault detection of linear flight control systems, together with an approach for integrated plant-and-controller optimisation in the linear-robust settings, has also been completed.

Flow Control in Aerospace Design

New methods improve design and performance of aircraft.

Scientists at the **Temasek Laboratories@NUS**, led by Dr Tsai Her Mann, are focusing on the fundamental aspects of flow control that can lead to the exploitation of flow phenomena for applications. They have made several achievements including: an original collar design with superior mixing qualities that reduce skin drag by about 30 percent; a new method for analysing the stability of vortex pair over wing-body structure, useful for designing new shapes that favour symmetric vortices formations with reduced roll moment and side forces; a novel technique to control the stall angle of a wing with the potential of doubling the lift coefficient and thus halving the wing size.



Effects of symmetric (double side) forebody spanwise slot blowing: Averaged images of vortex breakdown structures without (Cm=0.0) and with (Cm=0.2) double side slot blowing at AOA 20°.

Quantum Leap in Security

Quantum phenomena help achieve an impenetrable network of information security.

The Quantum Information Technology Lab at the NUS **Department of Physics** has been working on quantum mechanics in security and achieved a number of breakthroughs. These include the establishment of a quantum communication scheme in free space, and the application of Bell inequalities as entanglement witness, and entanglement as a physical resource for computing and communication.

In collaboration with Imperial College of London, the group comprising Prof Artur Ekert, Prof Oh Choo Hiap, Prof Lai Choy Heng and Dr Kwek Leong Chuan has proposed a scheme known as "Repeat-Until-Success" cluster state quantum computing using stationary qubits (quantum bits) and flying qubits (photons). On the experimental front, the researchers have implemented the Singapore protocol and successfully developed an optimal photon-counting polarimeter for state tomography under linear optics set-up.

New Media Piracy

First big-scale and in-depth study in Singapore explored consumers' piracy-related behaviour, attitudes towards media piracy, awareness of the legal implications of copyright infringement and understanding of intellectual property rights.

Dr Lim Sun Sun of Communications and New Media Programme at the NUS **Faculty of Arts and Social Sciences**, in collaboration with Assoc Prof Alan Tan Khee Jin from the NUS Faculty of Law, completed a national study on illegal downloading and purchase of pirated media by Singapore consumers. The key findings of the study were shared with an audience of policy makers, lawyers, copyright agencies, academics and scholars in January 2005 and the complete report was published by IP Academy in 2006. Many academics and copyright agencies from the region have invited Dr Lim to advise on or work with them on future studies of such nature. The findings of this study also received extensive media coverage locally.

Media Search

Analysis of news video content to support intelligence and personal content-on-demand applications.

Prof Chua Tat Seng, Dr Terence Sim and Dr Wang Ye from the NUS **Department of Computer Science** have developed several innovations in analysing video contents to support intelligence and personal content-on-demand applications. By combining face recognition techniques and statistical 3-D face models, they improve the robustness and reliability of face detection and recognition. To obtain better information, the researchers employ domain ontologies and hierarchical multi-modal mixture models for automatic visual concept annotation to retrieve sequence of video shots based on a text or multimedia query. By integrating text processing technology and query-dependent models to analyse query in news videos, video retrieval using multimodal fusion is attained. Introducing event models to track and retrieve temporal multimedia events enables video event tracking and synthesis.

The team's entries achieved top position in auto news video retrieval evaluations in TRECVID 2004–05 organised by the National Institute of Standards and Technology in the US. The work has attracted grants from Samsung and Electronics and Telecommunications Research Institute in Korea.

The user interface of a news video tracking and retrieval system. The system uses question-answering technologies to retrieve relevant sequences in news video based on text from automatic speech recognition output and audio-visual features.

Media and Natural Language Processing

Semantic processing of natural language text to support machine translation, and multi-lingual language processing.

Assoc Prof Ng Hwee Tou and Assoc Prof Lee Wee Sun from the NUS **Department of Computer Science** are researching into media and natural language processing. The highlights of their research include word sense disambiguation, semantic role labelling and Chinese word segmentation.

The team used semi-supervised learning algorithms and un-annotated texts to provide training examples to scale-up word sense disambiguation (WSD) research for better text understanding and machine translation. Innovations include adoption of a WSD system to different domains to achieve good accuracy, as well as the use of surrounding semantic arguments in free-text sentences to improve the accuracy of semantic role labelling.

Their Chinese word segmentor achieved the best overall performance in the open track of the Second International Chinese Word Segmentation Bakeoff in 2005.

Media, Text Processing and Information Retrieval

Semantic processing of textual information extraction, precise information retrieval and question-answering.

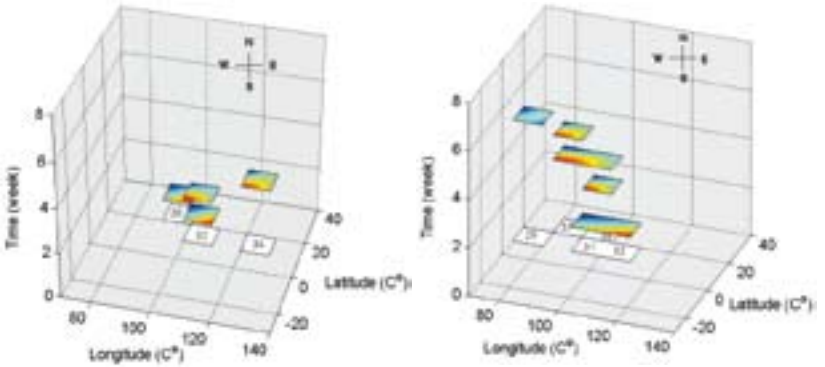
With the overwhelming amount of data from various sources, a need exists to find the right information. Prof Chua Tat Seng and Dr Kan Min Yen from the NUS **Department of Computer Science** are heading projects that employ artificial intelligence and other methods to extract salient knowledge.

Some highlights from the research include: Information Extraction that identifies semantic concepts in text such as names and key elements by using relations to derive invariant structures for sentences and cues for relation-based information extraction; Passage Retrieval that returns information at passage level in response to free text queries by utilising semantic relations with relation-based query expansion; Question-Answering that supports precise retrieval of information at phrase level by exploiting external knowledge from the web and ontologies to support interactive question-answering; and extension of research in vertical domain applications in legal search.

The team's question-answering entry at the international Text Retrieval Conference has come in second for the last 3 years. The technology has been licensed to a US company to support their patent and legal search.

Spatio-Temporal Data Mining

Database offers new possibility of mining new class of rules that capture changes and movement.



Spatio-temporal data mining algorithms have been applied to real-world forest fires satellite dataset from the Centre for Remote Imaging, Sensing and Processing.

Flow patterns / trend (far left): Fire Hotspots in Indonesia spread from West to East between March and April.

Flow patterns / trend (left): Fire Hotspots in Indonesia spread from South to Northwest between April and May.

Spatio-temporal applications have been rapidly gaining momentum in the last few years. In such applications, each object is related to another in a complex manner. Assoc Prof Wynne Hsu and Dr Lee Mong Li from the NUS **Department of Computer Science** have captured these complex interactions in spatio-temporal databases in the form of the past, present and future states of the modelled environment. They develop new techniques to find generalised spatio-temporal patterns, flow patterns and geographical features for location-based services. The results have been published in leading databases and data mining conferences.

High-Quality Images from Space

High-resolution geometric processing renders sharp images from space.

Researchers at NUS have improved the processing of commercial satellite imagery to a level comparable to the advanced quality found in highly sophisticated sensors and special equipment. Mr Kwoh Leong Keong, Ms Huang Xiaojing and Dr Liew Soo Chin from the **Centre for Remote Imaging, Sensing and Processing** (CRISP), together with **Temasek Laboratories@NUS**, developed a way to enhance the geometric accuracy of very high-resolution satellite imagery, to within 1m for IKONOS and 2.5m for SPOT-5 imagery. This method refines the satellite's camera model using rational polynomial coefficients (RPC). Existing approximate RPC refinement algorithms based on polynomial fitting of image coordinate residuals are only valid for narrow field of view cameras and over flat terrains. CRISP's approach refines the RPC based on physical imaging parameters and it is valid for narrow to wide field of view cameras as well as for flat to hilly terrains.

The new RPC refinement method enables accuracy improvement of almost all types of satellite imagery without a need to invest in complicated sensor-specific modules. A patent has been filed on the refinement of RPC camera model.

3-D Satellite Imaging

3-D visualisation software improves feature extraction of buildings from space images.

Commercial satellite imaging still faces limitations in producing accurate 3-D pictures of structures on the ground. Mr Kwoh Leong Keong, Ms Huang Xiaojing and Dr Yuan Bo at the **Centre for Remote Imaging, Sensing and Processing** have boosted 3-D visualisation of very high-resolution satellite imagery feature extractions by improving automatic extraction of building features from very high spatial resolution imagery. By matching the buildings in a stereo pair of images, building locations and heights can be automatically determined. The researchers have developed software for visualising 3-D city models by merging techniques in photogrammetry, computer graphics and computer science. This software is able to do fast rendering of the buildings and terrains using satellite images.

A 3-D city model generated with IKONOS imagery.

A 3-D image of Mount Everest generated with SPOT imagery.

A Programme on Imaging and Information Processing

Mathematics for the Information Age.

Rapid advances in communication, sensing and computational power have led to an explosion of data. The size and varied formats of these datasets present fresh challenges to existing techniques in terms of transmission, storage, querying, display and numerical manipulation. Research on computer-aided techniques to develop new technologies for data representation requires new theories and methods in the areas of approximation, imaging science, information processing, mathematical modelling, scientific computing and statistics.

The Mathematics and Computation in Imaging Science and Information Processing programme aims to conduct multi-disciplinary studies involving mathematical perspectives and foundation of imaging science and information processing. Organised by the NUS **Institute for Mathematical Sciences**, the programme brings together 340 local and international leading researchers of many disciplines. Notes for the tutorials will be published under the Institute for Mathematical Sciences *Lecture Notes Series*, with Assoc Prof Goh Say Song, Prof Amos Ron from the University of Wisconsin-Madison, US and Prof Shen Zuowei as editors.

Such a programme has increased the international profile of Singapore's research in mathematical image, signal and information processing. Interaction with colleagues, especially from overseas, enables Singapore scientists to further extend their existing international collaborative links and initiate new joint research projects.

Books published under the Lecture Notes Series.

Augmented Reality-Based Virtual Keyboards and Assistive Technology Devices

Gadgets and IT designed to replace or improve function of disabled and elderly.

Augmented reality-based assistive technology devices are designed to help the disabled or elderly carry out daily tasks by increasing their limited abilities through augmented information in various forms of interactive media, such as computer graphics and sounds customised to the users' needs.

Samsung Award for the Augmented Reality-Based Assistive Keyboard.

Project team: (from left) Prof Andrew Nee, Assoc Prof Ong Soh Khim and Dr Yuan Miaolong.

Conducted by Prof Andrew Nee, Assoc Prof Ong Soh Khim and Dr Yuan Miaolong at the NUS **Department of Mechanical Engineering**, the work will allow handicapped and elderly people to operate standard household equipment and communicate via the Internet and computer technology. Disabled students can also improve their written and oral communication skills through Virtual Keyboards as these can be accessed easily without a mouse or a physical keyboard. This project was selected as a recipient of the Samsung DigitAll Hope 2005 Awards.

Ideal and Reality in Asian Marriage

Research looks at decline in marriage and fertility in region.

The AsiaTrends Conference and book in 2004 was on the theme "(Un)tying the Knot: Ideal and Reality in Asian Marriage". The book by Prof Gavin Jones was one of the outputs of the "Changing Family" cluster, which has been analysing the striking decline in both marriage and fertility among educated urban Asians. Researchers from nine countries in the region have prepared research proposals on changing marriage patterns and their consequences at the **Asia Research Institute**-funded workshops. The Ford Foundation office in Jakarta funds six of these projects. Another conference in September 2006 on "International marriage, rights and the state in Southeast and East Asia" and workshop on "Muslim–non-Muslim marriage" will carry forward the theme of marriage change in the region.

Marriage and Baby Woes

Study to assess effectiveness of Singapore's pro-natalist policies on individual attitudes and behaviour.

Members of the population research team: (from left) Prof Gavin Jones, Assoc Prof Paulin Straughan, Dr Angelique Chan and Mr Elvin Xing.

Singapore recorded its lowest fertility rate of 1.24 in 2004. Concurrently, Singaporeans are getting married later, divorce rates are rising and more people are remaining single. For a nation-state that is dependent on manpower as an important resource, these changes in marriage and fertility behaviour are alarming.

Assoc Prof Paulin Straughan and Dr Angelique Chan from the NUS **Department of Sociology** and Prof Gavin Jones from the **Asia Research Institute** aim to investigate the attitudes of Singaporeans towards marriage, having children and raising them. Researchers believe that there are two possible causes for the trend: changes in the socio-economic situation; and shift in mindset and prioritisation of self-fulfilment. Understanding the reasons behind these changes is necessary in order to develop evidence-based policies regarding marriage and fertility behaviour.

Supporting Victims of Crime in Asia

Project serves as catalyst for more and better coordination of services for victims.

A project by Assoc Prof Chan Wing Cheong from the NUS **Faculty of Law** aims to bring together leading academics to assess the developments for victim support in the Asian region as well as the international trends and developments in this field. For some Asian countries, this is probably the first time that material on their criminal justice system is made available in English. Through this work, policy makers and social service providers in Singapore and elsewhere can be made more aware of the range of services developed in other countries. The project will serve as a catalyst for more and better coordination of services for victims of crime, as well as provide an opportunity to showcase the successful efforts in Singapore in this respect.

Studying Public Policy

Research produces two books that show that social policies in the region are shaped by domestic political factors and reveal surprising areas of strengths and weaknesses.

Prof M Ramesh's books on Social Policy in East and Southeast Asia published in 2004, together with the previous Welfare Capitalism in Southeast Asia, are cited by almost all research books and articles written on education, health, housing and social security in East Asia. The expert from the **Lee Kuan Yew School of Public Policy** has also written books and articles on social security and health policies in several East and Southeast Asian countries that form a standard starting point for research on the subject. His textbook *Studying Public Policy*, translated into several languages, is the world's most widely used book on the subject.

Citizen Activism in Japan

Crucial primary source materials relating to anti-Vietnam War movement and anti-pollution activism of the 1970s produce new conceptualisation of grassroots activism in post-war Japan.

Dr Simon Avenell of the NUS **Department of Japanese Studies** has conducted extensive research in citizen activism and the shaping of Japanese civil society. His research aims to illustrate the significance of tactics utilised by Japan's anti-Vietnam war and anti-pollution activists in the early 1970s for later activism; situate the development of Japan's third sector in the 1980s and 1990s within the Japanese social movement history from the 1970s; and to further develop the growing body of literature on the third sector and civil society in Japan. A paper based on the project has been published in *Japan Forum* (the Japanese Studies Association of Britain's official journal) in 2006. Two other publications in academic journals and a book on the topic are also under preparation.

Dr Simon Avenell in his office at the Department of Japanese Studies.

Asian Cultural Studies

Cultural studies cluster promotes analysis of popular culture in Asia.

The Cultural Studies cluster at the **Asia Research Institute** helmed by Prof Chua Beng Huat and Assoc Prof Chen Kuan-Hsing has helped establish the sub-discipline of cultural studies in Asia. It also contributes to the marked advances in analysing contemporary popular culture in East Asia. The cluster's recent publications include Dr Khoo Gaik Cheng's *Reclaiming Adat: Contemporary Malaysian Film and Literature* (2005), Dr David Lim's *The Infinite Longing for Home: Desire and the Nation in Selected Writings of Ben Okri and K.S. Maniam* (2005); and Dr Cherian George's *Contentious Journalism and The Internet* (2006). The External Review Board has commended on the cluster's openness and envisions it becoming the premier location in the region for cultural analysis.

Language in the Bilingual Brain

Findings of project will have implications on understanding of how different languages are processed in human brain.

An important question in the study of language in the bilingual brain is whether and to what extent cortical representation of the bilingual's first and second languages overlap. Neuroimaging techniques such as functional magnetic resonance imaging (fMRI) and positron emission tomography (PET) have allowed researchers to address this question more fully. However, as Paradis (2004) pointed out: "The results of neuroimaging studies with bilingual subjects are beginning to look as contradictory as those of bilingual lateralization studies…in the 1970s and 1980s".

A team of researchers led by Dr Tomasina Oh from the NUS **Department of English Language and Literature** and Dr Steven Graham from the NUS **Department of Psychology**, with clinical input from National University Hospital's consultant neurologist Dr Bernard Chan and senior speech therapist Mr Isaac Sia, aim to investigate the neural correlates of language in the bilingual, and specifically address the problems that contribute to the contradictory findings in this area. The study involves both healthy and brain-damaged bilingual speakers and will re-visit and re-interpret contradictions present in previous data.

Background to Aceh Conflict

Institute's involvement in Aceh reconstruction.

The Aceh conflict was one of the longest and bloodiest in Indonesia before the peace of August 2005 in the wake of the terrible tsunami. A 2004 **Asia Research Institute** conference that examined the situation resulted in the 2006 book *Verandah of Violence: The Background to the Aceh Conflict* by Prof Anthony Reid. The publication has already been hailed as providing "the best overview to date" of the Aceh problem. Research on the issue has also led to a second book by Reid, and growing involvement in the cultural dimensions of the reconstitution.

From Traditional Jawi Script to New World Technology

Development useful for academic fields like political science, linguistics, Malay studies, literary studies, economics, sociology and social anthropology.

Jawi is an Arabic-derived script that was commonly used throughout the Malay world. However, in modern times it has been displaced by Romanised Malay, and Jawi script has become an almost archaic and impenetrable script for many native Malay speakers.

The Jawi Transliteration Project (JTP) is in the process of creating the world's first Jawi newspaper text archive consisting of 3,500 newspaper articles from pre-War Singapore and Malaysia. Run by Assoc Prof Timothy Barnard and Dr Mark Emmanuel from the NUS **Department of History**, JTP will provide the Malay community and scholars around the world access to a fully-searchable database of newspaper articles in both Romanised form as well as in its original Jawi script.

The source material has already been made available on the web through the Malay Concordance Project, which is based at the Australian National University and used for teaching Malay linguistics at Leiden University, Netherlands. The project is important in helping to reclaim a significant part of Singapore-Malay historical heritage.

Top right: An editorial titled "Kaum Ibu Didalam Johor" (Women in Johor) from Warta Malaya, 3 February 1930. Bottom right: A page from Lembaga Melayu (c. 1929-30), a Singapore-based Malay language newspaper edited by Eunos Abdullah, a well-known Singapore Malay intellectual.

Skills Management Amid Hi-Tech Changes

Study commissioned by World Bank as part of the background papers for the Regional Workshop on Investment Climate and Competitiveness in East Asia.

Led by Assoc Prof Shandre Thangavelu from the NUS **Department of Economics**, the research aimed at the preparation of an analytical study on the management of appropriate skills in a fast growing economy with rapid technological change. The study focused on the Malaysian experience and presented a comparative perspective of Korea and Ireland.

Tracking Goods from Factory to Store

RFID system improves inventory management in supply chain.

With large amounts of goods being transported around the globe, keeping track of inventory can be a major nightmare. To address this challenge, **The Logistics Institute – Asia Pacific** is looking at how radio-frequency identification (RFID) can improve the inventory management of a supply chain system. A team comprising Assoc Prof Lee Loo Hay, Assoc Prof Chew Ek Peng and Dr Sim Chee Khian explored ways RFID can impact inventory management when formulating a supply chain model. With a RFID system, a distribution centre can be notified if there are sudden disruptions at the supply-side, and can then expedite orders from upstream parties. Although costs are incurred initially, potential savings can be generated through reduction in inventory holding and back order.

Integrating RFID into inventory policy is a relatively new area of research. The NUS team has done work on ordering policy for inventory systems with expediting decision under stochastic demands and are using RFID to develop proof of concepts, as well as new knowledge and methodologies in inventory management.

Performance of China's Listed Companies

Unique database of ownership structure, product diversification and performance.

Assoc Prof Andrew Delios at the **NUS Business School** has developed an unusually detailed database. The information should facilitate unique examinations of ownership identity, company strategy and performance. It also addresses a broadly recognised limitation in the recent literature on ownership identity in China's publicly owned firms, namely that the currently official scheme has too many ambiguities to be useful.

The research has been published in leading journals and one paper has been nominated for the prestigious Haynes Prize. A website has been created to make the database available to other researchers.

Optimum Berth Management in Container Terminal

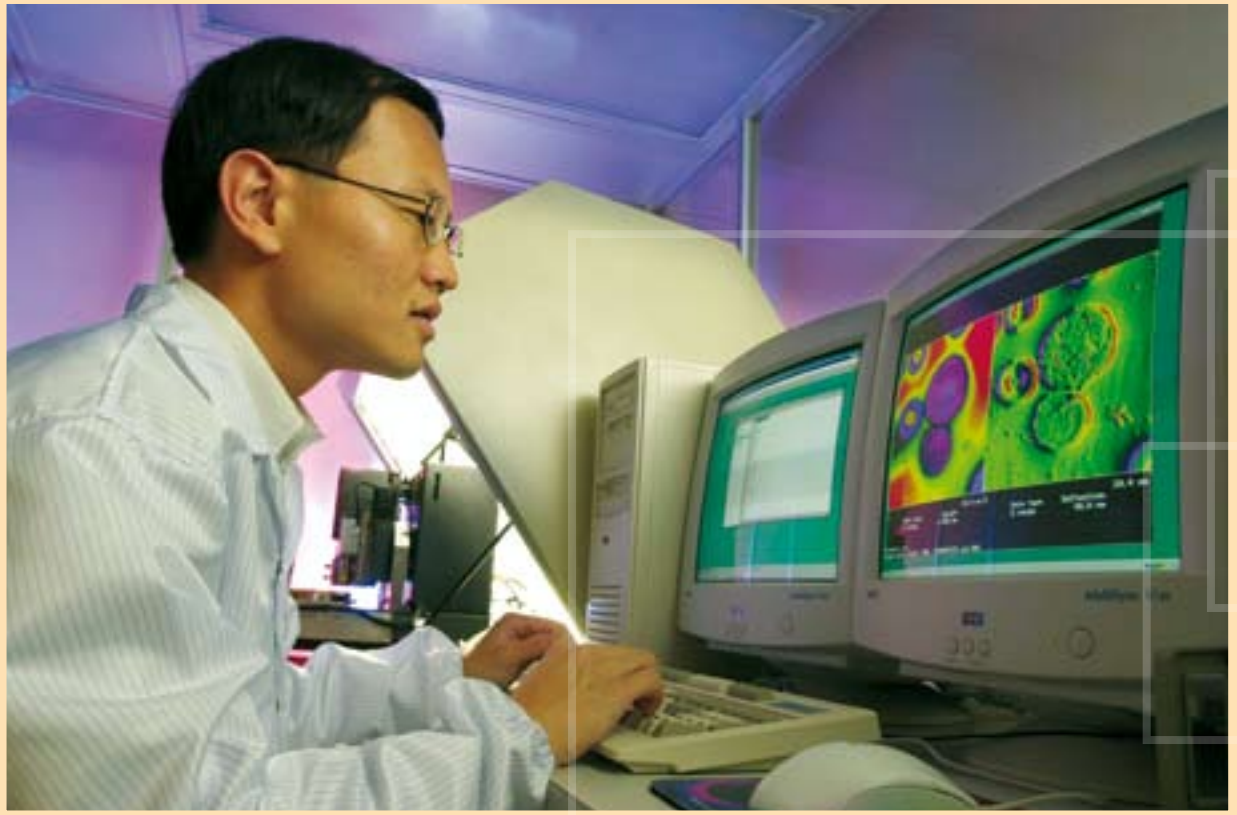
Simulation software addresses berth allocation and home berth problem at a port.

The logistics of vessel berthing is a complex planning and operations problem, especially for a busy port like Singapore. A major portion of the port resources are utilised in transporting containers between vessels, thus vessels with many containers to be transported between them should preferably be berthed close to each other.

Assoc Prof Teo Chung Piaw and team from the **NUS Business School** have developed a simulation software for addressing berth allocation planning and home berth problem in container operations. Modelled as a bi-criteria optimisation problem, the researchers designed a framework to deal with the trade-off between the operational cost and service levels demanded. To tackle the randomness of vessel arrival, they borrowed techniques from stochastic project scheduling and derived an expression for expected delays. The model addresses both the combinatorial and stochastic nature of the problem and creates robust home berth allocations, translating to better service levels and resource management.

The team believes that this is the first published work that solves a berth template problem and analyses the impact of the template on real-time berth allocation. The Port of Singapore Authority is using the model to extend its research into this area.

RE: SEARCH COLLABORATION 3



- More than 1,000 collaborative projects annually
- Integrating inter- and cross-disciplinary work
- Partnerships local, regional and international
- Holistic approach arising from diversity
- Mutual benefits and leverage from partnerships

RESEARCH COLLABORATION

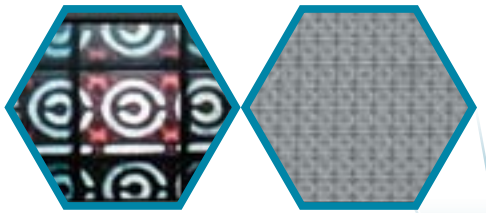
Researchers at the Organic Nano Device Laboratory at NUS.

Fabricating Next-Generation Electromagnetic Meta-Materials

Discovery will impact telecommunications, information technology, life sciences and military applications.

Singapore researchers, together with the Massachusetts Institute of Technology (MIT), have synthesised electromagnetic meta-materials (EM^3), a novel artificial material with superior electromagnetic properties that cannot be found in naturally occurring materials. The novel material promises many new functionalities and enhancements to future optical and optoelectronics devices such as high-speed circuits, high-resolution imaging systems and higher-capacity optical data storage systems.

Led by Prof Herbert Moser of the **Singapore Synchrotron Light Source**, in collaboration with MIT and **Temasek Laboratories@NUS**, the team successfully applied lithography to the manufacturing of the EM^3, producing the first microelectromagnetic meta-materials at the far infrared region (1–2.4THz). Continuing these efforts towards nanofabrication, the researchers were able to produce electromagnetic meta-materials operating at a record frequency of 187.5THz, which is near telecommunications frequencies (~194THz). The current composite materials can potentially be implemented as novel lightweight infrared sensors.



EM^3 made of gold rod-split-ring-resonator structures < 1μm in outer diameter.

High-Mobility Electron Transport Property of Organic Semiconductors

Opens up new opportunities for organic complementary metal-oxide-semiconductor (CMOS) technologies in which both p- and n-type behaviours can be harnessed.

It is believed that electrons are generally not mobile, which has given rise to the prevailing notion that n-channel field-effect transistors (FETs) can only be made from a restrictive class of special organic materials. However, a recent discovery by Dr Peter Ho and his team at the Organic Nano Device Laboratory, NUS **Department of Physics**, together with the team of Prof Richard Friend at the University of Cambridge and Dr Eric Ou at Singapore's Institute of Materials Research and Engineering, proved otherwise.

Using interface-sensitive spectroscopy, they determined that the traditional device structures, which employed silicon oxide on silicon to test for such properties, caused particularly severe electron trapping at the dielectric–semiconductor interface. By careful selection of the gate dielectric, they showed that n-channel FETs can in fact be obtained from a wide range of organic semiconductors, with unprecedented high electron mobility. The breakthrough work was published in *Nature* in 2005 and has entered the Top 10 most cited 2005 papers in the physical sciences of *Science Watch*.

Characterisation of Anti-Cancer Agent

Study of novel multi-target molecular agent in cancer treatment.

Assoc Prof Chen Chien Shing from the NUS **Department of Medicine** is collaborating with Abbott Laboratories, US to characterise the drug efficacy, sensitivity and resistance for A-741439 (ABT-869) alone or in combination with chemotherapy for acute myeloid leukaemia *in vitro* and *in vivo*. ABT-869 is a novel multi-target kinase inhibitor which is on its way into clinical trial and the opportunity of getting novel agent at the early phase of development is very important for NUS' clinical programme. The study aims to develop a potential novel treatment for cancer patient which is not available at this stage.

GEM^4 Addresses Global Medical Challenges

Focus can range from fundamental science to clinical studies and public health.

The NUS **Faculty of Engineering** has joined the Global Enterprise for Micro-Mechanics and Molecular Medicine (GEM^4). Launched in October 2005, the international collaboration seeks to bring together scientists, engineers and health professionals from institutions around the world. GEM^4 grew out of NUS' joint venture with Massachusetts Institute of Technology and Institut Pasteur on malaria research. Other participating institutions include Harvard University, Max-Planck Institute, University of Illinois at Urbana-Champaign, Georgia Institute of Technology, Caltech, John Hopkins University, University of California San Diego and Chulabhorn Research Institute in Thailand. The collaborative programme has its secretariat based at the University.

The NUS delegation with NUS President Prof Shih Choon Fong after the official launch of GEM^4.

First row (from left): Assoc Prof B V R Chowdari (Physics), Assoc Prof Michael Raghunath (Bioengineering), Prof Shih, Prof Barry Halliwell (Biochemistry) and Assoc Prof Lim Chwee Teck (Mechanical Engineering/ Bioengineering). Second row (from left): Prof Chew Yong Tian (Mechanical Engineering), Prof Bill Schowalter, Prof Raj Rajagopalan (Chemical and Biomolecular Engineering), Ms Ying Ying (student) and Dr Kevin Tan (Microbiology).

Allergy–Asthma Network in Asia-Oceania

Singapore leads the team formed to validate European findings for healthcare needs of the region and develop innovative means to improve healthcare management.

The European Commission approved the formation of the Global Allergy and Asthma European Network (GA^{2}LEN) in 2004 and awarded it a grant of €14.4 million for a period of 5 years. In 2005, the GA^{2}LEN General Assembly appointed its only non-European collaborating centre, GA^{2}LEN-PAO, a partnership in Asia-Oceania.

Coordinated by Assoc Prof Wang De Yun from NUS **Department of Otolaryngology**, the Asia-Oceania project involves 24 universities and research centres from 12 countries. It is the largest multi-ethnic population genetics study across the three continents using well-characterised model organisms for predicting and testing gene functions. This cross-fertilisation of expertise and collaborative research will be done in a trusted environment resulting in sharing of new knowledge and benefiting evidence-based medicine, biomedical research, global education, industrial R&D, progressive healthcare policies and greater collaboration among small- and medium-sized enterprises.

Pathogenesis Study of Hepatitis B Virus

Will lead to better understanding in the treatment of the disease.

Little is known about the evolution of Hepatitis B virus (HBV) over time unlike that of HIV and Hepatitis C virus in which viral quasispecies evolution has a close relationship to disease pathogenesis. Assoc Prof Lim Seng Gee from the NUS **Department of Medicine** and his collaborator Prof Allen Rodrigo from the Bioinformatics Institute, New Zealand, a world-renowned expert on analysis of viral quasispecies, used a proprietary software the latter developed to analyse HBV quasispecies in well-defined clinical phenotypes of chronic Hepatitis B.

The researchers cloned and sequenced the gene, believed to be the target of host immune response during HBV infection. A total of 3,386 sequences were analysed with regards to viral diversity, viral evolutionary rate, and evolution development tree construction using bioinformatics techniques. Their findings indicate that HBV viral behaviour is closely related to clinical progression of disease from an immunotolerant phase to an immunoclearance phase, and that immune response in Hepatitis B may be related to development of new viral epitopes generated by the increased viral diversity.

Laser "Tweezers" in Study of Malaria-Infected Cells

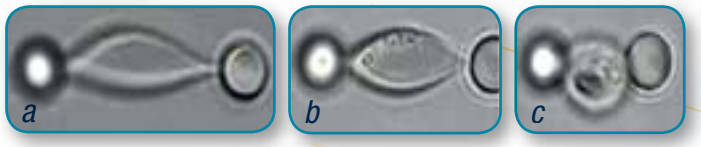
Findings may reduce parasite's virulence and lead to ways to interfere with changes in infected cells.

Malaria infects an estimated 500 million people a year and kills about 3 million, mostly children. The disease is caused by *Plasmodium*, a parasite transmitted by the female *Anopheles* mosquito.

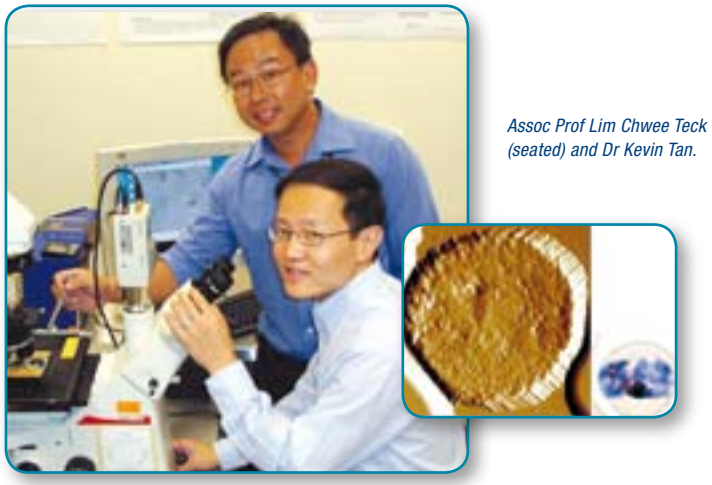
Assoc Prof Lim Chwee Teck from the NUS **Division of Bioengineering** and **Department of Mechanical Engineering** and Dr Kevin Tan from the NUS **Department of Microbiology** have teamed up with researchers from Massachusetts Institute of Technology (MIT) and Institut Pasteur to study malaria using advanced nanobiomechanics.

Healthy red blood cells can stretch, bend and even fold as they traverse through blood vessels less than half their diameter. However, cells infected with the malarial parasite become rigid and sticky, clogging capillaries that carry blood to the brain and other vital organs. To understand the little-studied changes, the researchers are using a state-of-the-art equipment called "laser tweezers" to stretch red blood cells to investigate how stiff the infected blood cells can get. They also observe microfluidic channels to study how these cells can clog vessels and capillaries.

The team won the Ribbon Award (Outstanding Paper Award) at the Material Research Society Fall Meeting in 2004. The March 2006 issue of *Technology Review* by MIT recognises the nanobiomechanics work as one of the Top 10 emerging technologies that will impact human lives.



Stretching of a (a) normal, (b) mid-stage and (c) late-stage malaria-infected red blood cell using a laser trap.



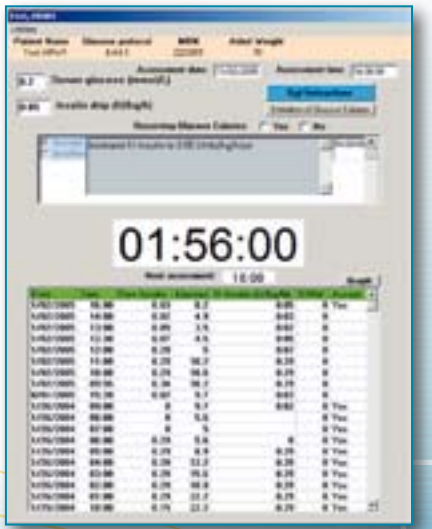
Assoc Prof Lim Chwee Teck (seated) and Dr Kevin Tan.

Atomic force microscopy image and the corresponding giemsa-stained image of a late-stage Plasmodium falciparum-infected red cell.

Insulin-Glucose Control in ICUs

Findings will change acute insulin-glucose management.

NUS and National University Hospital are joining hands with US institutions to study insulin-glucose control in intensive care unit (ICU) patients. The collaboration with Johns Hopkins University, University of Virginia and LDS Hospital in Utah represents the first non-US site on a US National Institutes of Health grant. Led by Assoc Prof Lee Kang Hoe from the NUS **Department of Medicine**, the project represents the start of utilising decision support in the complex environment of an ICU, and promises to have the potential to change the paradigm of the treatment of acutely ill patients. The results have been presented in many meetings and a manuscript is in preparation for *New England Journal of Medicine*.



Insulin-glucose decision support system used in management and control of ICU patients.

Perfecting Artificial Kidneys

Team aims to further refine technology through innovative membrane development and advancement in new materials.

Artificial kidney is one of the pioneering products available in the market today. Bioactive and biomimetic membranes used for artificial organs are important technological advances due to the complexity of membrane formation, sophistication of device design, and its ability to preserve human life. However, the technology is far from perfect as a study in 2003 showed that patient survival rates were only about 78 percent, 63 percent, 32 percent and 9 percent for 1-, 2-, 5- and 10-year kidney dialysis users, respectively.

Prof Neal Chung Tai-Shung from the NUS **Department of Chemical and Biomolecular Engineering** and BASF Chemicals are combining BASF's knowledge on polymers and NUS' strengths on membrane formation and biomolecules separation to study the separation performance and potential of BASF proprietary polysulfone membrane to design bioactive membranes that can be applied in haemodialysis.

Genetic Determinants of Diabetic Nephropathy

Identifying genes that contribute to disease susceptibility will yield greater insight into its causes and is likely to generate novel avenues for its prevention and treatment.

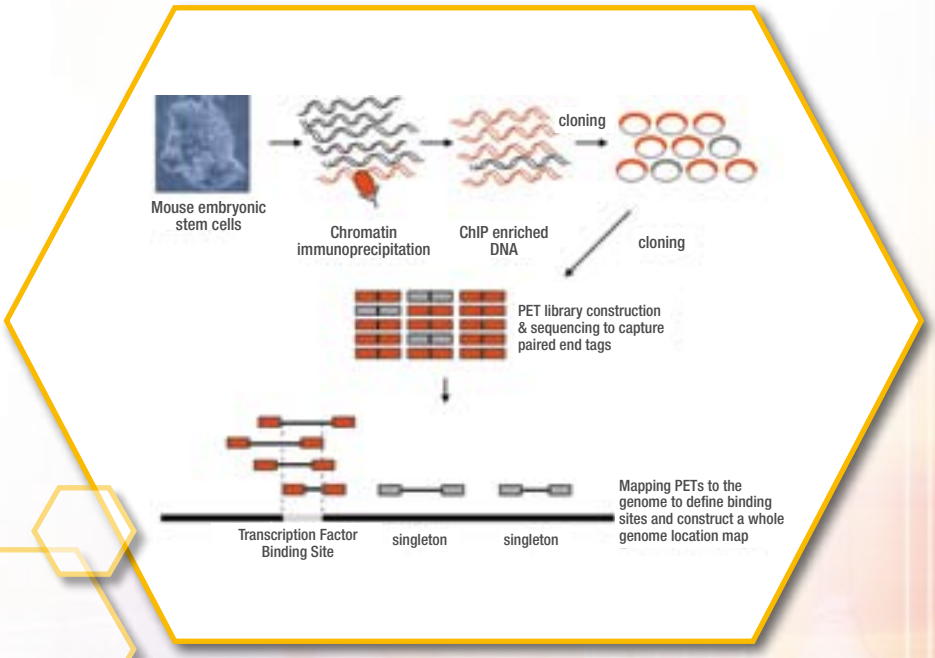
Diabetic nephropathy is the major cause of end-stage renal disease in Singapore and other developed countries. Dr Daniel P K Ng from the NUS **Department of Community, Occupational and Family Medicine** established collaborations with renowned international institutions in the US, Europe and Japan to perform cross-population studies that complemented local effort to identify the culprit genes in a sample of more than 3,000 diabetic patients in Singapore. Noteworthy is a long-standing collaboration with Dr Andrzej Krolewski from the Joslin Diabetes Center and Harvard Medical School, a leading expert in the genetic epidemiology of diabetes and its complications. This partnership has resulted in publications in premier diabetes and nephrology journals.

Discovery of Proteins Controlling Stem Cell Behaviour

Finding helps scientists understand how to use stem cells for curing debilitating diseases such as cancer and Alzheimer's Disease.

Dr Ng Huck Hui from the NUS **Department of Biological Sciences** and group leader at the Genome Institute of Singapore (GIS), together with his team of 23 local and international scientists, uncovered 4,000 locations in the human genome where special proteins control the functions and activities of stem cells. The team used a technology developed by GIS that enabled large-scale mapping of the proteins, and allowed scientists to determine the exact locations of the switches that triggered certain functions in the genome.

The US National Institutes of Health was so impressed that it awarded US$1 million funding to the research. The work was published in *Nature Genetics* in March 2006.



Cutting-edge technology to identify the binding sites of transcription factors in living stem cells.

Baby Cells in Mum's Brain

Promise of non-invasive stem cell-based therapies for neurodegenerative diseases.

Singapore scientists have discovered that some foetal stem cells cross the blood-brain barrier into the mother's brain during pregnancy and differentiate into different types of nerve cells. This finding holds exciting possibilities in non-invasive cell-based therapies for neurodegenerative diseases as well as enables live study of how foetal stem cells behave in the adult brain. Hitherto, stem cells have to be cultured outside the body before being introduced to the brain, a process that could damage the brain and change the cell property.

The team led by Dr Gavin Dawe and Dr Xiao Zhi Cheng from NUS **Department of Pharmacology**, with members from Singapore General Hospital and Institute of Molecular and Cell Biology, is now determining the molecular markers in these foetal cells that help them cross to the brain. This would enable the identification of stem cells from other sources like umbilical cord blood that can be used to repair the brain by non-invasive methods.

Knowledge Discovery from Clinical Data

Study of patterns and development of new machine learning methods investigated through analysis of pathways, gene features and gene expression.

The computational biology project is jointly conducted by the NUS **Department of Computer Science** and Institute for Infocomm Research. Researchers have produced significant results which include mining of equivalence pattern classes based on odds ratio, relative risk and other statistics more sophisticated than those achieved in traditional data mining algorithms; development of protein function prediction without sequence homology using protein interaction data; speeding up of inference of RNA secondary structure; and the recognition of mitochondrial RNA precursors with over 90 percent sensitivity and specificity.

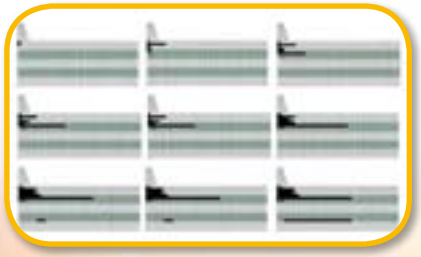
Accurate Aircraft Damage Prediction Modelling

SIFT-EFM cost-effective solution to critical damage propagation problems for lightweight composite airframes.

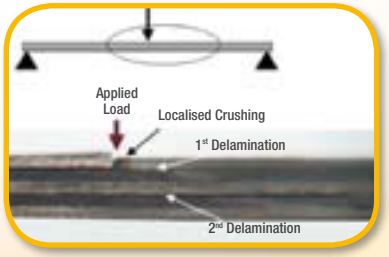
Assoc Prof Tay Tong Earn (second from right) with international collaborators at Boeing, Seattle, US.

A research collaboration between NUS, Boeing Aircraft Co and Stanford University aims to address critical issues in new-generation composite airframes such as durability, damage progression modelling, and cost and weight reduction. NUS **Department of Mechanical Engineering** researcher Assoc Prof Tay Tong Earn developed a novel progressive damage modelling methodology for the analysis of lightweight composite aircraft structures called the Element-Failure Method (EFM). It incorporates the effects of damage into nodal force modifications in computational models and simulations of complex damage growth. The method has great implications because it does not explicitly model the overwhelmingly numerous microcracks, delaminations and fibre breaks in composite materials and structures, yet it enables accurate predictions of damage growth patterns when compared to experimental data. Furthermore, the solution is always guaranteed, with little or no numerical instability.

The integration of EFM with a new failure criterion called Strain Invariant Failure Theory (SIFT) proposed by Boeing has resulted in powerful computer models and tools. This new SIFT-EFM technology has been used successfully to model very complicated and difficult damage propagation problems in composites. The work is gaining worldwide attention through numerous talks and lectures.



Predicted damage and delamination progression.



The three-point bend test and observed damage and delamination pattern.

Conic Optimisation and Applications

Expanding research in optimisation increases applications in science and engineering including control theory, combinational optimisation, structural optimisation, signal processing, circuit design, ad hoc wireless sensor networks and robust optimisation.

Researchers from the NUS **Department of Mathematics**, working together with 12 universities from the US, UK, China, Hong Kong and Australia, have proposed a new definition of underlying paths for the semidefinite linear complementarity problem and analysed the analyticity of these paths, which is a basic property in the complexity analysis and local convergence analysis. The scientists have fully solved the important and difficult open problem of characterising the strong regularity and strong stability for nonlinear semidefinite programming (SDP).

The NUS team has developed new algorithms for convex quadratic semidefinite programming (QSDP). Their inexact primal-dual path-following algorithms for QSDP are among the first that are able to solve a general convex QSDP efficiently. The group has applied conic programming techniques to address problems in discrete optimisation with uncertainty and choice models and in financial mathematics in bounding option prices of multi-assets. New tools to analyse queueing and inventory systems using these techniques have also been developed.

Abstract Theory of Braids

Theory enables applications to outstanding problems in physics, chemistry and biology.

The notion of a braid as “anything plaited, interwoven or entwined” goes back many centuries, and braids have been used in many cultures for decorative, artistic and fastening purposes. Only recently have mathematicians tried to describe braids by means of abstract theory.

Prof Jon Berrick, Assoc Prof Wu Jie and Dr Wong Yan Loi of the NUS **Department of Mathematics**, with collaborator Prof Fred Cohen from University of Rochester, US, have revealed an astonishing relationship between braids and the homotopy groups of spheres. These groups can be considered as the building-blocks of homotopy theory in algebraic topology, a central and seminal area of modern mathematics.

Their results have been published in the most-cited mathematics journal *Journal of the American Mathematical Society*.

Maths Organisation to Advance Pacific Rim Science and Technology

PRIMA concerted effort of leading mathematical institutions to promote development of mathematical sciences and their applications.

The **Institute for Mathematical Sciences** has become the only member from Southeast Asia in the Pacific Rim Mathematical Association (PRIMA). PRIMA comprises members from leading mathematical institutions including the Mathematical Sciences Research Institute, Pacific Institute for the Mathematical Sciences, American Institute of Mathematics, Australian Mathematical Sciences Institute, and School of Mathematical Sciences at Peking University.

The organisation was formed following the Pacific Rim Mathematical Forum held in Canada in October 2005. Some of PRIMA’s activities include the organisation of summer schools for graduate students, scholar exchanges, organisation of a Pacific Rim Congress, and sharing of benefits of expertise among institutes.

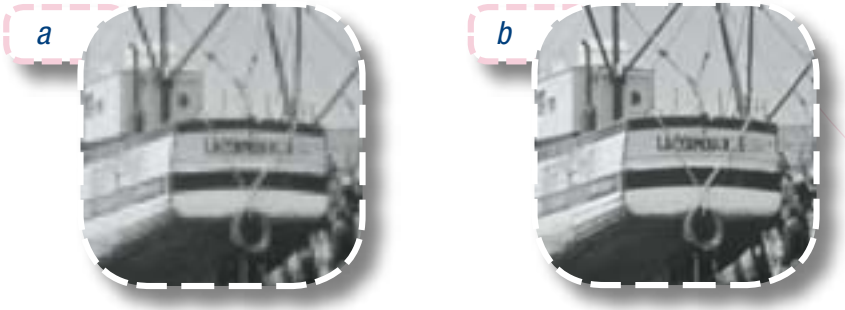
Participants at the Pacific Rim Mathematical Forum in Canada.

Wavelets, Information Processing and Mathematical Imaging

Collaboration a platform for highly innovative multi-disciplinary research involving state-of-the-art mathematical theories, and for engaging international experts in the area.

Led by Prof Shen Zuowei, Assoc Prof Goh Say Song and Dr Andy Yip Ming-Ham, the project by the Centre for Wavelets, Approximation and Information Processing at the NUS **Department of Mathematics** investigated topics on wavelets, frames, uncertainty principles, causality properties, signal and image denoising, 3-D wavelet video compression, super and high-resolution image and video reconstruction, methods for image restoration, geometric partial differential equation (PDE) methods for data clustering, and recovery of missing data. The study is done in collaboration with experts from 13 universities and institutions, including Princeton University, University of California Los Angeles, University of Alberta, University of Dundee, Australian National University and Chinese University of Hong Kong.

Some of the group members are co-principal investigators of the research programme "Wavelets and Information Processing" at the **Temasek Laboratories@NUS**, funded by Singapore's Defence Science and Technology Agency. The programme has developed a number of useful new technologies for image and video compression and underwater signal processing based on the mathematical techniques and algorithms in the area. These technologies include a system for compressing sequence of images of video mosaic, which has been deployed in the video mosaic system of DSO National Laboratories in Singapore.



High-Resolution Image Reconstruction: (a) An image acquired by an imaging device. (b) A high-resolution image (4X) reconstructed from low-resolution frames using a wavelet-based algorithm developed at the Centre for Wavelets, Approximation and Information Processing.

Banda Aceh before tsunami.
Satellite imagery taken on 10 Jan 2003.

Banda Aceh after tsunami.
Satellite imagery taken on 29 Dec 2004.

Mapping of Tsunami-Affected Aceh

High-resolution satellite imagery used for planning rehabilitation and reconstructing livelihoods of fishing communities.

The December 2004 Indian Ocean tsunami caused severe damage to lives, properties and infrastructure in Aceh, Indonesia. While the most severe destruction occurred in the western coast and the north-western tip of Sumatra, the more extensive coastal pond aquaculture activities located in the east coast were also affected.

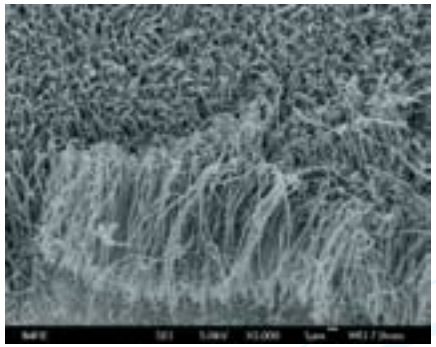
Dr Liew Soo Chin and Ms Chen Ping from the **Centre for Remote Imaging, Sensing and Processing** are joining efforts with the WorldFish Centre and Syiah Kuala University in Banda Aceh to map tsunami-affected coastal aquaculture areas in northern Sumatra using high-resolution satellite imagery for planning rehabilitation and reconstruction efforts. This project has recently received funding from the United Nations Office of Outer Space Affairs, Programme on Space Applications.

Disaster Management Network in Asia Pacific

Pilot project "Sentinel-Asia" to establish network using data acquired by remote sensing satellites for disaster management in the region.

A joint initiative by the **Centre for Remote Imaging, Sensing and Processing** (CRISP), Australia's Commonwealth Scientific and Industrial Research Organisation, Japan Aerospace Exploration Agency and other remote sensing agencies in the region, the core of the network is a web-based geospatial information system running on several distributed nodes for disseminating environmental information derived from satellite data. CRISP has implemented a system for near-real-time distribution of fire hot spots maps. This system will be expanded to include environmental information pertinent to other disasters such as floods, drought and harmful algal blooms.

Carbon nanotube sensors.



Carbon Nanotube Sensors

Inter-disciplinary team to develop novel, rapid-response biochemical sensors for targeted chemical and biological molecules.

Nanosensors based on advanced nanomaterials are expected to emerge in the marketplace in significant volumes over the next 10 years. Sensors constructed at the molecular scale are extremely sensitive, selective and responsive, making them ideal for detecting small amounts of chemical or biological agents.

Assoc Prof Sheu Fwu-Shan from the NUS **Department of Biological Sciences** and colleagues at the **NUS Nanoscience and Nanotechnology Initiative** are working together with the Massachusetts Institute of Technology to show that the nanosensors can selectively detect in real time a single chemical species down to nanomolar concentrations. Adopting the ordered nanotubes arrays — chemically functionalised nanotubes and sensors based on conjugated polymers developed by MIT researchers — the team aims to show how the combination of this expertise and capability will make it possible to produce novel state-of-the-art biochemical and contaminant sensors.

Improved Measurement of Oceanic and Atmospheric Pollutants

New model improves the estimation of POP fluxes between the ocean and atmosphere.

Persistent organic pollutants (POPs) such as pesticides and industrial compounds are globally distributed through the environment and are of great concern due to their persistence, carcinogenicity and endocrine-disrupting effects on wildlife and humans. Tropical Asia is a prime source of many semi-volatile POPs due to their extensive use and associated global atmospheric dispersion. Assoc Prof Jeff Obbard, from the NUS **Division of Environmental Science and Engineering** and **Tropical Marine Science Institute** (TMSI), and colleagues at NUS have investigated the fate and distribution processes of POPs in various regions of Asia.

The gas exchange between the ocean and atmosphere is a major pathway of POPs to the atmosphere in tropical regions controlled by the sea-surface microlayer (SML). This layer, 50–100µm above the ocean, is often enriched with POPs when compared to the bulkwater, as shown in Singapore and Hong Kong waters in a project with City University in Hong Kong. Atmospheric data on POPs in Singapore were used to model the air–sea gas exchange via the SML and compared to conventional models ignoring the layer.

In another study conducted with Research Assoc Prof John Potter from TMSI, rare atmospheric data of POPs were collected and evaluated on temporal trends over the last three decades. The comparative study over six regions of the Indian Ocean showed that the concentrations of pesticides such as DDT have declined significantly since the mid 1970s, but hit a high at the beginning of the 1990s. The decline of atmospheric POPs may be due to stricter international regulation of the use of these compounds. This study also provides the first atmospheric data on polybrominated diphenyl ethers (PBDEs), a class of flame retardants, collected over the open ocean. The information strengthens the assumption that these are globally distributed and have to be considered as a new class of POPs.

Left: A sampler device to skim the uppermost layer of the ocean with a thickness of 50–70µm.

Bottom: Air sampling on a sailing boat over the Indian Ocean.

Environment-Safe Antifouling Agents

Development of pharmaceutical-based compounds into commercially useful and environment-safe antifouling additives for marine coatings.

As a result of the ban on organotin marine paints, there has been an increase in R&D for new environment-safe antifouling paints. The aggressive and biodiverse fouling rates in Singapore waters provide opportunity for rapid performance testing and development of new marine antifouling coatings. In 2004, **Tropical Marine Science Institute** (TMSI) researchers identified several pharmaceuticals with potential antifouling properties and filed a US patent. In collaboration with the Singapore Institute for Chemical Engineering and Sciences (ICES), the project has received funding from the Joint Tertiary Research Institutions (TRI) and Maritime Port Authority (MPA) R&D Programme. The cross-disciplinary project involves drug design and polymer chemists from ICES, environmental microbiologists from NUS **Division of Environmental Science and Engineering**, marine biologists from TMSI and experts in antifouling research from Duke University and Marquette University in the US. TMSI is also involved in a collaborative project on the Marine Antifouling Performance and Biocorrosion in Singapore waters, funded by Singapore's Defence Science Technology Agency and US Office for Naval Research, to evaluate the performance of antifouling coatings in Singapore's coastal waters.

Co-Extinction of Species and Disturbance on Rainforest Bird Biodiversity in Southeast Asia

Studies look into loss of unknown and yet potentially useful plants and animals in the ecosystem and impact of massive habitat loss on biodiversity.

Assoc Prof N Navjot Sodhi from the NUS **Department of Biological Sciences** and colleagues at Princeton University, University of Tennessee and University of Connecticut have jointly released a report on *Conservation and Extinction of Species*. The researchers used mathematical equations to calculate expected levels of co-extinction to uncover these widely overlooked phenomena. They believe that co-extinction could be a substantial contributor to the present global extinction crisis, and that estimates of species extinction should be re-examined, taking the new estimates into account. The findings, which were published in *Science*, generated considerable international attention.

In a related study, Assoc Prof Sodhi examined the effects of habitat loss, in particular, on the birds of Southeast Asia. His research on different locations in Indonesia, Peninsular Malaysia and Singapore showed that habitat degradation compromises not only bird diversity but also that of other organisms such as butterflies. He found that the sensitivity differs among bird species and landscapes. For example, as much as 80 percent of pristine forest is needed to retain all forest bird species in some areas such as the montane forests of Peninsular Malaysia.

Assoc Prof Sodhi's paper published in *Nature* has attracted worldwide interest. Data from the project will help the conservation efforts in Southeast Asia. The results have been shared with various agencies such as the National Parks Board of Singapore to assist in conservation and management efforts.

Assoc Prof Navjot Sodhi capturing birds in Sulawesi. All birds captured were identified, measured and released.

Master Plan considerations for the spatial incorporation of water infrastructure.

Master Plan for Water Infrastructure

First-of-its-kind planning tool enables planners and architects to study and develop water infrastructure quantities related to land use, urban design and housing typology.

Assoc Prof Joseph Lim from the NUS **Department of Architecture** and collaborators, Prof Heng Chye Kiang and Dr Ong Boon Lay from the NUS **Department of Architecture**, and Prof Ng Wun Jern from the NUS **Department of Civil Engineering**, investigated the problem of estimating catchment areas and storage tank volumes in the physical planning of townships, in the land-scarce and water-scarce context of Singapore. This is crucial in exploring the feasibility of harnessing rainwater with land to be distributed optimally for targeted population densities.

The team developed a modelling tool that facilitates the planning of housing townships with rainfall data and relevant parameters controlling overflow, storage and catchment. The study includes the complex interrelations of the urban hydrological cycle, limitations of rainwater management, aesthetic roles of water in architecture and landscape in historic and contemporary context, and a hypothetical water Master Plan for Punggol township, alternative to the as-built version, which subsists on 50 percent water supply from the Singapore Public Utilities Board (PUB). Since 50 percent of water demand could be met with rainwater and treated greywater, this implies the possibility of subsisting with the PUB water supply without purchasing water from outside Singapore.

The programme allows different rainfall data to be loaded for location-specific modelling. The Singapore Housing and Development Board is currently reviewing the project for possible prototype study.

A Commencement Meeting for the EU-EAEF Projects was held in Greece in 2005. Assoc Prof Lee Siew Eang (sixth from the left) in a group photo of all the project members.

Modelling Building Energy Performance

Outputs will significantly reduce energy services business cost, enhance energy services procurement know-how, and develop professionalism within the energy services sector as a whole for ASEAN.

In 2005, the EC-ASEAN Energy Facility Programme awarded two European Union grants for projects led by the Energy Sustainability Unit of NUS. Headed by Assoc Prof Lee Siew Eang from the NUS **Department of Building**, the team includes Belgian Building Research Institute, the International Network for Information on Ventilation and Energy Performance, Centre Scientifique et Technique du Batiment, IEN Consultants and the Malaysia Centre for Energy.

The first project on Development of a Business Model for Building Energy Performance Services in the ASEAN Region aims to develop a framework model for the procurement, financing, measurement and evaluation, and verification of building energy efficiency retrofitting projects. It will be very useful to energy services procurers such as building owners and management, as well as energy services companies, particularly for ASEAN practices. The second project is for the Development of a Comprehensive Database for Building Energy Performance Benchmarking in ASEAN.

Singapore Household Housing Choices

Study indicates limited effectiveness of government policies to vary subsidy to new flats across different flat types and the unintended distortions in lifecycle housing consumption among new flat buyers.

Jointly funded by NUS and CapitaLand Pte Ltd, the study is a first in Singapore to examine consumer housing choice behaviour using household-level data. The team, comprising Assoc Prof Fu Yuming and Dr Lum Sau Kim from the NUS **Department of Real Estate** and Dr Boaz Boon and Dr Steven Choo from CapitaLand, focused on the Singapore Housing and Development Board (HDB) housing market, where new flats were sold by the government to eligible households at below resale-market prices. The team used the unique institutional feature of the HDB market to test the effects of non-price rationing, queuing and balloting on homebuyers' behaviour.

The econometric analysis produced two major findings. Researchers found that the pseudo prices of the non-price rationing for new flats were responsive to variations in expected resale profit across different HDB flat types such that they eliminated the differential expected resale profits. The second finding showed that income eligibility regulation rationing new flats encouraged homebuyers with high income potential to apply for new flats earlier in their lifecycle in order to obtain the housing subsidy from the government before their income exceeded the ceiling imposed by HDB.

Family Ties in Singapore

A good reference for policy-makers in Asia Pacific.

Assoc Prof Peggy Teo and Prof Brenda Yeoh from the NUS **Department of Geography**, together with Dr Elspeth Graham from the University of St Andrews in the UK, studied inter-generational relationships for their implications on fertility and family in Singapore. With funding from NUS and the Economic and Social Research Council, UK, the research findings generated a great deal of interest among academia and the public. The results led to three international reviewed publications, a local newsletter publication, one unpublished report, five conference papers and two seminar presentations. It will be an invaluable reference for policy-makers in Asia Pacific and elsewhere.

Scholarly Network Studies Southeast Asian History and Literature

Exploration of the history of interaction among diverse groups in a zone extending from Nakhon Si Thammarat in southern Thailand to the northern Malaysian states.

The **Asia Research Institute** (ARI) is collaborating with Thailand's Regional Studies Program at the Institute of Liberal Arts, Walailak University, and Institute of Asian Studies, Chulalongkorn University, to bring together scholars based in Southeast Asia to look at the historical, linguistic and literary dimensions in the region.

The collaboration aims to examine from different perspectives an area of Southeast Asia on which limited and challenging source materials have made research difficult; to establish an informal network of scholars interested in the history of this zone of transition between mainland and maritime Southeast Asia; and to produce an edited volume on the topic with revised versions of papers presented. To-date, the team has published a book on *The Plural Peninsula: Studies in the History of Ethnic Interactions in Southern Thailand and Northern Malaysia*, edited by ARI's Dr Patrick Jory and Dr Michael Montesano.

New Perspectives in Political Reform

Insights from recent reform experiences aim to improve quality of democracy in the Philippines.

A joint project between **Asia Research Institute** and the Philippines Social Science Council examines the political reform and charter change in the Philippines.

Organised by Assoc Prof Paul Hutchcroff from the Institute, an international workshop was hosted in the Philippines where insights from recent reform experiences in a select number of other Asian countries were shared. The collaboration provides an opportunity for extensive analysis of major issues by local participants as well as overseas delegates. It brings new perspectives in debates over constitutional reform; more importantly, it is hoped that these perspectives would heighten the quality of public discourse over issues of constitutional reform and contribute to the emergence of reforms that are most effective in improving the quality of democracy in the Philippines. An edited volume on *Political Reform and Charter Change in the Philippines* was subsequently produced.

NUS President Prof Shih Choon Fong presenting tokens of appreciation to Mr John Stansfield, Lloyd's Register Asia (left) and BG Tay Lim Heng, MPA (right).

Professorships to Boost Offshore Engineering and Maritime Research

Setting up of professorships an important tripartite collaboration between industry, government agency and tertiary institution, and a significant step towards creating a dynamic maritime R&D cluster in Singapore.

The Lloyd's Register, Maritime and Port Authority (MPA) of Singapore and NUS have pledged S$9 million to establish two professorships. The Lloyd's Register Professorship and Maritime Technology Professorship at the Centre for Offshore Research and Engineering, NUS **Faculty of Engineering**, are jointly set up by NUS and the Singapore Economic Development Board. The professorships will support offshore research and engineering as well as maritime R&D through the participation of prominent visiting professors and renowned industry experts.

Under the Memoranda of Understanding signed in December 2005, Lloyd's Register and MPA will each commit S$3 million while NUS will seek from the government a dollar-for-dollar matching grant. This is the first time that Lloyd's, which is a leading international classification society and risk management organisation, has committed funds for a professorship outside the UK.

IBM–NUS Supply Chain Solutions Centre

Collaboration brings together expertise from different universities to provide unique perspectives on advanced supply chain research.

The IBM–NUS On Demand Supply Chain Solutions Centre, a partnership between industry giant IBM and NUS, was officially launched in March 2005. The centre aims to integrate the knowledge generated into the advancement of the supply chain profession and curriculum design and development.

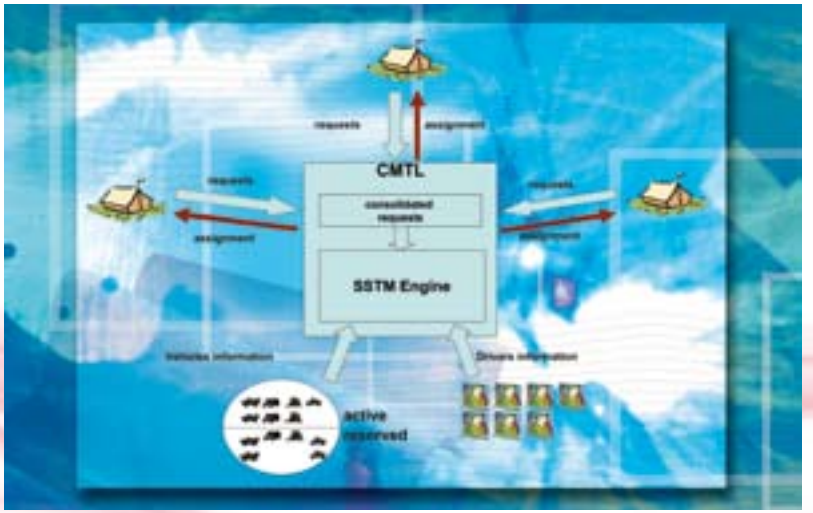
In line with NUS Faculty of Engineering's drive to have a design-centric curriculum that is industry-relevant, the NUS **Department of Industrial and Systems Engineering** set up a teaching laboratory equipped with the latest state-of-the-art hardware and software solutions and support services from IBM. As a result of this global partnership, NUS became the fifth member of the IBM integrated Supply Chain University Partnership in July 2005. The other four partner universities are Arizona State University, Michigan State University, Pennsylvania State University and the University College, Dublin.

JAGUAR Attacks Optimisation and e-Logistics

Programme serves to enhance Singapore Ministry of Defence's logistics efficiency and readiness by leveraging on commercial best practices.

JAGUAR, a collaborative programme of the Singapore Armed Forces, Georgia Institute of Technology and NUS, focuses on two broad tracks: Resource Optimisation, involving the development of methodologies and tools for optimisation across the military supply chain; and e-Logistics, which looks at developing advanced logistics applications enabled by the Internet in the new economy.

One resource optimisation system developed by Dr Lau Hoong Chuin's team at **The Logistics Institute – Asia Pacific** is the Shared Service Military Transport Management System (SSTM). It manages large fleets of vehicles and consolidates vehicle depots with centralised control. It does this by using tools that minimise the active fleet size based on various requirements such as number, skills and experience of drivers, and specified allowable delay. Using real-life data with two types of vehicles, the system is able to produce savings of 29 percent for Type 1 vehicles, and savings of 37 percent for Type 2 vehicles.



The Shared Service Military Transport Management System (SSTM) under the JAGUAR programme manages large fleet of vehicles based on resource optimisation.


RE: SEARCH AWARDS
4

- More than 150 awards received yearly
- Outstanding work highly cited
- Distinction in research excellence
- Achievements in broad-ranging fields
- In a league of the best

RESEARCH AWARDS

international

Most Highly Cited Researchers

Four NUS researchers received the rare honour of making it on the list in 2005. **Prof Shih Choon Fong**, President of NUS, was ranked by the Institute of Scientific Information as one of the most cited researchers for engineering in the world. His research has focused on nonlinear fracture mechanics and innovative computational methods for studying crack propagation.

Prof Barry Halliwell, NUS Deputy President (Research and Technology), was recognised for his work on antioxidants and molecular mechanisms of cell injury and death. **Prof Philip Keith Moore** who heads the **Department of Pharmacology** was acknowledged for his study on biologically active gases in inflammation and cardiovascular physiology. **Prof Harald Niederreiter**, from the **Department of Mathematics**, received the honour for his research in cryptography and coding theory.

Most Highly Cited Researchers (clockwise from top): Prof Shih Choon Fong, Prof Barry Halliwell, Prof Philip Keith Moore and Prof Harald Niederreiter.

Distinguished Pathologist

Emeritus Prof K Shanmugaratnam, emeritus consultant, **Department of Pathology**, was presented the Distinguished Fellow Award by the Royal College of Pathologists of Australia in 2006. He is a world-renowned histopathologist who has served in the World Health Organization as well as various committees and commission of the International Union Against Cancer.

Outstanding Achievement Awards

Assoc Prof Marie-Veronique Clement from the **Department of Biochemistry** received the Outstanding Achievement award given by the *International Journal of Oncology, Oncology Report* and *International Journal of Molecular Medicine in 2004*.

Integrative Medical Researcher

Assoc Prof Wong Tien Yin from the **Department of Ophthalmology** researches into the integration of traditional research methodology and new medical technologies such as computer-based imaging. He also adopts an inter-disciplinary approach by studying the eye in relation to other organs. For his outstanding work, he was awarded the 2004 Young Investigator Award by the Asia Pacific Society of Hypertension. He was also presented the Sandra Daugherty Award for Excellence in Cardiovascular Epidemiology by the American Heart Association, and the Viertel Clinical Investigator Award by the Sylvia and Charles Viertel Charitable Foundation.

Willi Hennig Society Awards

In 2005, a group of students from the **University Scholars Programme** (USP) bagged two of the top three student awards at the 24th Willi Hennig Society Meeting in Norway. The meeting saw a gathering of biologists from around the world. The top prize of best student presenter went to **Kathy Su Feng Yi** from the **Department of Biological Sciences**. **Department of Psychology** undergraduate **Farhan Ali** won the Don Rosen Award for being the third best student presenter.

Robot World Cup Champion

A total of 83 teams from 16 countries competed at the International Robot-Soccer Association World Cup in 2005. The Humanoid (MaNUS) created by NUS **Department of Electrical and Computer Engineering** final-year student **Mr Tan Li Yu** and **Dr Prahlad Vedakkepal** topped the humanoid category by winning 3 out of 4 events in this category.

Robot World Cup Championship – humanoid category.

Leading-Edge Manufacturing Achievements

The Japan Society of Mechanical Engineers gave out the LEM21 Leading Edge Manufacturing Achievements Award, 2005 to **Prof Mustafizur Rahman** of the **Department of Mechanical Engineering**. This award recognised Prof Rahman's success in solving the existing problems and assumptions of the cutting force model and making it a generic model.

Prof M Rahman with the miniature diamond lathe for nanosurface generation.

Entrepreneurship Wins

BioMers, a start-up venture by former **Department of Restorative Dentistry** research assistant **Ms Karen Teo** and **Department of Mechanical Engineering** postgraduate **Ms Renuga Gopal**, won the Special Prize for the Best Technology Impact Plan at the Intel-UC Berkeley Technology Entrepreneurship Challenge in 2005. It also bagged the First Prize at the Inaugural Idea to Product (I2P) Asia Competition in 2005, as well as received an Honorable Mention at the University of San Francisco Business Plan Competition 2005. The start-up venture was based on orthodontic composite work led by **Prof Chew Chong Lin** from the **Department of Restorative Dentistry** and **Prof Seeram Ramakrishna** of the **Department of Mechanical Engineering**.

IEEE Honour

Prof Bernard C Y Tan, head of **Department of Information Systems** earned an Honorable Mention for Best Paper by IEEE Transactions on Engineering Management in 2004 for his paper *"Reporting Bad News about Software Projects: Impact of Organizational Climate and Information Asymmetry in an Individualistic and a Collectivistic Culture"*.

Norman Medal for Civil Engineering

Assoc Prof Phoon Kok Kwang from the NUS **Department of Chemical and Biomolecular Engineering** and his co-authors, F H Kulhawy and M D Grigoriu of Cornell University, won the Norman Medal 2005 from the American Society of Civil Engineers. Their paper, "*Multiple Resistance Factor Design for Spread Foundations*", was judged the best paper of the year for its coverage on effect of geologic variabilities on foundation design risk using probability theory, which is simplified to a form directly useful to practitioners.

Assoc Prof K K Phoon receiving the Norman Medal from the President of the American Society of Civil Engineers (ASCE), William P Henry at Los Angeles, 2005.

Best MIS Reviewer

MIS Quarterly gives out the Best Reviewer of the Year Award each year to one top reviewer among the 450–500 reviewers for the journal. **Assoc Prof Teo Hock Hai** from the **Department of Information Systems** won the 2005 title, the first time a researcher from outside North America has won the award.

Daimler Chrysler and UNESCO Recognise Young Engineers

Students from the **Division of Environmental Science and Engineering** were the top winners of the 2005 Mondialogo Worldwide Engineering Award, launched by Daimler Chrysler and UNESCO. The NUS team comprising **Ms Ng Kai Scene**, **Ms Cindy Koh Lee Yin** and **Mr Marvin Joseph Montefrio** also earned the "Laureate Special Jury Recognition" for its project proposal entitled "A Sustainable Approach to the Control and Remediation of Municipal Solid Waste Leachate at the Payatas Disposal Facility in Metro Manila, Philippines", which was supervised by Assoc Prof Jeffrey Obbard.

Chinese Physics Achievement

Assoc Prof Li Baowen, **Department of Physics**, received the 2004/2005 Overseas Chinese Physics Association's Asia Achievement Award for the discovery of thermal diode and thermal transistor.

Nanotech Prize

Prof Chua Soo Jin, of the **Department of Electrical and Computer Engineering** and **NUS Nanoscience and Nanotechnology Initiative**, bagged the first prize at the MRS-Singapore Conference on Advanced Materials in 2006 for his paper *"Nanoscale selective area lateral overgrowth of GaN"*. He also won the first prize at the 3rd International Conference on Materials for Advanced Technologies 2005 for his paper "*Nanoheteroepitaxy of GaN on a nanopore array of Si(111) surface*".

Above: Nanotech Prize – Prof Chua Soo Jin (left) with PhD student Ms Zhang Keyan from the Advanced Materials in Micro- and Nano-systems Programme at Centre for Optoelectronics, NUS.

US National Academy of Engineering Foreign Associate

The US National Academy of Engineering elected **Prof Miranda Yap Gek Sim**, of the **Department of Chemical and Biomolecular Engineering**, as a Foreign Associate in 2006. The appointment is among the highest professional distinctions accorded to an engineer who has made outstanding contributions to the field. Prof Yap was recognised "for her outstanding achievements in education, research and management in the field of mammalian cell culture".

French Order

Prof Louis Chen, director of the **Institute for Mathematical Sciences**, was conferred Chevalier dans l'Orde des Palmes Academiques in 2005 by the French Government for his contribution to relations between France and Singapore within the academic field.

Institute of Commonwealth Studies Fellowship

Dr Kripa Sridharan from the **Department of Political Science**, won the Henry Charles Chapman Fellowship 2005/06 awarded by the Institute of Commonwealth Studies, University of London to conduct research on South Asian politics and foreign policy.

Tianjin Urban Planning

Prof Heng Chye Kiang and **Mr Low Boon Liang** from the **Department of Architecture** submitted the winning entry in the International Urban Design Competition for the Redevelopment of French Heritage District awarded by Tianjin, China. The winning proposal optimised the redevelopment potential of the French District to solve its physical and economic dereliction while protecting its most significant buildings and street character and urban spaces. The two architects also won the International Urban Design Competition for the Xiaobailou CBD Plaza, Tianjin organised by the city.

Detailed plan of the winning entry in the Tianjin French Heritage District International Urban Design Competition.

UNESCO Heritage Innovation

Assoc Prof Li Xiaodong from the **Department of Architecture** and **Dr Lim Guan Tiong** from the **Department of Building**, won one of two UNESCO Heritage Awards Jury Commendation for Innovation 2005 presented by UNESCO. They designed and built the Yuhu Primary School and Community Centre in Lijiang, China through re-interpretation of local traditions and materials. The school was given the Asia Pacific UNESCO Heritage Awards Jury Commendation for Innovation in Year 2005.

Team in Lijiang with students of Yuhu Primary School.

Chinese Studies Award

Dr Lee Chee Hiang from the **Department of Chinese Studies** received in 2004 the Chaoxue Awards (1st Class) that is awarded every three years by the Chaoshan History and Culture Research Foundation, China. The award was for the book *The Migration Experience of Overseas Teochews* edited by him in 2003.

J. G. Crawford Award

Dr Takashi Terada from the **Department of Japanese Studies** won the 2005 J.G. Crawford Award given by the Australia-Japan Research Centre, Asia Pacific School of Economics and Government, Australian National University in 2005 for his paper *"The Japan-Australia Partnership in the Era of an East Asian Community: Can They Advance Together?"*

Best Business Papers

NUS Business School received recognition by a number of international associations. In 2004, **Assoc Prof Inmoo Lee** of the **Department of Finance and Accounting** won the Best Paper Award at the Asian Finance Association Meetings. **Dr Ishtiaq Mahmood** from the **Department of Business Policy**, together with Dr Chung Chi-Nien and graduate student Ms Sheng Zixia, were the First Runners-up for the Haynes Prize for Best Paper by the Academy of International Business (AIB). **Dr Melvyn Sim** from the **Department of Decision Sciences** was the second place winner of the George Nicholson Student Paper Competition at INFORMs the same year.

Right: (from top) J. G. Crawford Award winner, Dr Takashi Terada; Best Business Paper winners Assoc Prof Inmoo Lee, Dr Ishtiaq Mahmood and Dr Melvyn Sim.

Singapore

National Science and Technology Awards

The National Science and Technology Awards are presented by the Agency for Science, Technology and Research (A*STAR) for outstanding research in Singapore.

Dr Ng Huck Hui from the **Department of Biological Sciences** won the 2004 Young Scientist Award for his work in gene regulation. Three NUS researchers won the 2005 Young Scientist Awards: **Assoc Prof Edward Teo Ho Khoon** from the **Department of Physics** for his work in general relativity, quantum field theory and black diholes; **Dr Peter Ho** from the **Department of Physics** for his research on organic semiconductor devices; and **Dr Leonard Ang Pek Kiang** from the **Department of Ophthalmology** for his research on ocular stem cells, bioengineering and ocular surface transplantation for the treatment of eye disease.

Assoc Prof Li Baowen from the **Department of Physics** won the 2005 National Science Award for his pioneering work in theoretical physics which contributes to the understanding of heat conduction and control of heat flow at microscopic level.

The Enterprise Challenge

Dr Victor Fan and **Dr Cao Tong** from the NUS **Department of Oral and Maxillofacial Surgery**, together with Rapid-Tech Pte Ltd, received the Enterprising Agency Award in The Enterprise Challenge (TEC) 2005 presented by the Prime Minister's Office. The team invented a bioscaffold made of a polymer that is able to biodegrade in the body within six months, leaving no toxic effects and yet retaining the necessary strength and shape to allow bone regeneration.

The Enterprise Challenge winners Dr Cao Tong (seated) and Dr Victor Fan.

Defence Awards

The **Acoustic Research Lab**'s Remotely Operated Ambient Noise Imaging System (ROMANIS) team led by Assoc Prof John R Potter snagged the Defence Technology Prize Team Award (R&D) by Defence Science and Technology Agency in 2004. The **Tropical Marine Science Institute**'s system is the first broadband digital ambient noise imaging camera of its kind.

Dr Terence Sim Mong Cheng, **Department of Computer Science**, won the 2005 Temasek Young Investigator Award jointly presented by NUS and the Defence Science and Technology Agency for his work on face recognition, which focuses on enhancing the capabilities of face recognition systems in speed and robustness. The award is given to outstanding researchers working in areas of potential use in defence and national security.

Dr Terence Sim (far right) receiving the Temasek Young Investigator Award from Prof Lui Pao Chuen, Chief Defence Scientist, Ministry of Defence. NUS Deputy President and Provost Prof Tan Chorh Chuan (centre) was guest-of-honour at the award ceremony.

university awards

Young Researcher Award

Dr Joseph Ooi Thian Leong from the **Department of Real Estate** received the 2005 Young Researcher Award for his research in international real estate encompassing corporate and securitised real estate and asset pricing dynamics. **Assoc Prof Edward Teo Ho Khoon** from the **Department of Physics** was presented the award for unravelling the mysteries of general relativity and quantum field theory. **Dr Yao Shao Qin** from the **Departments of Chemistry** and **Biological Sciences** won the award for his studies of the functions and structure of proteins to identify key proteins pertinent to diseases.

Dr Leonard Ang Pek Kiang received the 2006 Young Researcher Award for his significant contribution to stem cell research at the **Department of Ophthalmology**, establishing Singapore as a leading centre in the world for eye-disease treatment. **Assoc Prof Mark Breese** from the **Department of Physics** won the award for his research that has led to greater understanding of the interactions between high-energy ion beams with crystal lattices and defects. He also received the World Scientific Medal (Physics Research, 2005) awarded by the Singapore Institute of Physics.

Recipients of the Young Researcher Award 2005: (back row, from right) Dr Yao Shao Qin, Assoc Prof Edward Teo and Dr Joseph Ooi.

The Outstanding Researcher Award was presented to Assoc Prof Hong Yunhan (back row, fourth right), Assoc Prof Shazib Pervaiz (back row, fourth left), and Assoc Prof Marie-Veronique Clement (back row, third left).

Recipients of the Young Researcher Award 2006: Dr Leonard Ang (back row, second right) and Assoc Prof Mark Breese (back row, fourth left).

The Outstanding Researcher Award 2006 went to Prof Lee Eng Hin (back row, third right) and Prof Lee Hian Kee (back row, fifth right).

Outstanding Researcher Award

Assoc Prof Hong Yunhan from the **Department of Biological Sciences** won the 2005 Outstanding Researcher Award for his work in medaka fish embryonic stem cell lines and test-tube sperm. **Assoc Prof Shazib Pervaiz** from the **Department of Physiology** and **Assoc Prof Marie-Veronique Clement** from the **Department of Biochemistry** won the Team Award for their study of carcinogenesis and the development of more selective agents to fight drug resistance in cancer.

Prof Lee Eng Hin from the **Department of Orthopaedic Surgery** was awarded the 2006 Outstanding Researcher Award for his research in tissue engineering and stem cells. **Prof Lee Hian Kee** was the other winner for his pioneering work on liquid-phase microextraction (LPME) at the **Department of Chemistry**. His research has led to further development of LPME approaches for on-site sampling without the need of sending samples back to the lab for processing.

RE: PATENTS, COMMERCIALISATION & SPIN-OFFS 5

- More than 150 patents filed each year
- Translating fundamental research to application
- Useful discoveries commercialised
- Successful marriage of research and enterprise
- Spin-offs gaining international foothold

PATENTS, COMMERCIALISATION & SPIN-OFFS

Patents

Therapeutic Venoms

Snake venom can kill but with a little help from scientists, they can also heal.

A team led by Prof P Gopalakrishnakone from the NUS Venom and Toxin Research Research Programme at the **Yong Loo Lin School of Medicine** has developed **Therapeutic Molecules** from the venom of the King Cobra. The analgesic peptide, prohanin, is a small peptide derived from hannalgesin, a toxin exhibiting analgesic effects isolated from the venom of the snake. Prohanin, a stable and very water-soluble peptide, does not show any toxin-like properties similar to hannalgesin yet retains the latter's pain-killing property — thousands of times more potent than morphine in animal pain models. It is unique in that it is effective through intraperitoneal, oral or sublingual administration.

The patented peptide has been licensed to biotechnology start-up ProTherapeutics Pte Ltd, a joint venture by NUS, the Singapore Economic Development Board and the Agency for Science, Technology and Research. The company will re-engineer the prohanin to generate small peptides which can be taken orally, are non-addictive and more effective than morphine. The NUS researchers are planning to develop prohanin into an analgesic drug suitable for sublingual administration. It is currently being investigated for efficacy in neuropathic, inflammatory and other pain models.

The venom of the King Cobra can be developed into an analgesic thousands of times more potent than morphine.

Healthy, Non-Leaching Diet for Fish Larvae

New diet suitable for large-scale hatchery use and has good potential for production and marketing as commercialised product.

Marine hatcheries require special feeds for rearing fish larvae and other marine organisms. In the case of fish larvae, live feeds such as *Artemia* are the preferred food source but these can be expensive and labour-intensive to produce. Collaboration between the Marine Aquaculture Research Group at the **Tropical Marine Science Institute** (TMSI), the GEA-NUS Pharmaceutical Processing Research Laboratory (GEA-NUS PPRL) of the **Department of Pharmacy** and the Marine Aquaculture Centre of the Agri-Food and Veterinary Authority (AVA) has resulted in the successful development of a **New *Artemia* Replacement Diet** for marine fish larvae in the form of a dry particulate diet. This new formulation remains well-dispersed in the water column, is attractive and readily ingested by the larvae, and does not leach nor dirty the water in the rearing tanks.

The TMSI team led by Dr Juan Walford tested the diets prepared by Assoc Prof Paul Heng's team at GEA-NUS PPRL by carrying out feeding trials with Asian seabass larvae at the TMSI experimental aquaculture facility on St John's Island. The AVA team carried out large-scale hatchery trials using successful formulations at their Marine Aquaculture Centre hatchery. The results showed that the diet can successfully replace feeding with *Artemia*, as the growth and survival of the larvae reared on the particulate feed were similar to those of the larvae fed enriched *Artemia*.

Members of the research team: (from left) Emeritus Prof T J Lam (Biological Sciences/ TMSI), Assoc Prof Paul Heng (Pharmacy/ GEA-NUS PPRL), Dr Juan Walford (TMSI) and Ms Guo Qi Yun (GEA-NUS PPRL).

Automatic Fingerprint ID

Invention an improved method for characterising, matching and identifying unique features such as fingerprints.

As society becomes increasingly electronically-connected, passwords and personal identification numbers are no longer sufficient for security and authentication. There is a growing need for automated personal authentication that is secure and unique. Dr Tham Jo Yew, Prof Lee Seng Luan and team at the NUS Centre for Wavelets, Approximation and Information Processing, **Department of Mathematics**, have developed a **Wavelet-Enhanced Automated Fingerprint Identification System** to address such a demand. In particular, it relates to methods for enhancement of digital images, fast directional convolution and fingerprint-oriented ridge thinning, matching and identification of fingerprints.

The patented system has a biological data matching system that includes: a pre-enhancing unit adapted to pre-enhance the personal biological image data according to local areas of contrast; an image smoothing and enhancement filter for improving pre-enhanced image data; an orientation data thinner for removing false data in the image data; a registration unit for aligning the personal biological image data with the template image data; and a matching score unit for determining if the biological data matches the template print.

Besides fingerprint, the system can also be used in iris, voice, hand geometry, face or palm pattern, thus it has great potential for biometric applications.

Integrated Micromachining Tools

Multiprocess feature tool increases accuracy in machining.

Until recently, a work piece that requires multiple machining processes had to be fabricated using different machines such as microelectrical discharge machine (EDM), microturning, microdrilling and micromilling. Prof M Rahman and his team at the NUS **Department of Mechanical Engineering** have developed a **Miniature Machine Tool for Micromachining**, which integrates multiple micromachining processes into a single system. With this unique multiprocess feature, electrodes used in EDM processes can now be fabricated on the same machine. These electrodes are then used to fabricate features on a work piece. Inaccuracies due to clamping and damage during transfer are minimised, greatly increasing the precision. For this invention, the team received the IES Prestigious Engineering Achievement Award 2004.

The patented integrated tool has the potential of serving the precision and ultra-precision industries and has been licensed to spin-off Mikrotools founded by Prof Rahman.

Efficient Query Processing of High-Dimensional Data

Method speeds up indexing, useful for large databases.

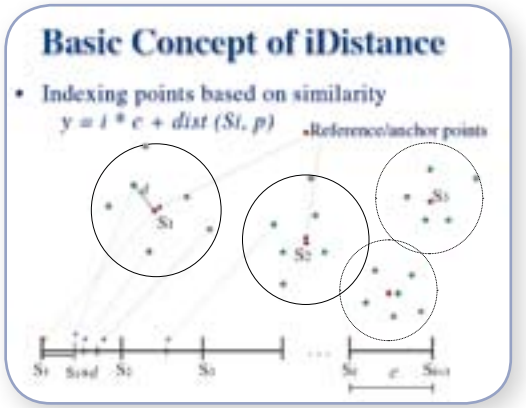
Prof Ooi Beng Chin, Assoc Prof Tan Kian Lee and PhD student Ms Yu Cui from the NUS **Department of Computer Science** have developed a method called iDistance for efficiently processing such queries.

Patented as **Transformation-Based Method for Indexing High-Dimensional Data for Nearest Neighbour Queries**, the technique maps the problem into one that operates in a single-dimensional space. Instead of working with the high-dimensional points, the researchers use the 1-D distance between the high-dimensional points and some pre-determined reference points. This results in very efficient processing and enables the team to tap into existing single-dimensional tools available in commercial systems. Most of the existing technology operates at the native space, that is, the high-dimensional space or a reduced multi-dimensional space. As such, it cannot be readily adapted for use in commercial systems.

The new method is currently the most efficient technique reported in the literature and is adaptive to different data distributions. It is useful for applications that manage large databases of high-dimensional points.

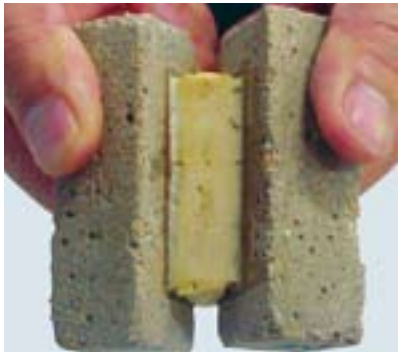
In a related project that involved Dr Stephane Bressan, the team devised a method called iMinMax for efficiently processing queries that retrieve all points that fall within a query box. The **Apparatus and Method for Performing Transformation-Based Indexing of High-Dimensional Data** developed transform a high-dimensional point into a single-dimensional space so that all processing can be efficiently done in the single-dimensional space. Besides allowing the use of existing single-dimensional tools, the invention has a tuning knob that offers the flexibility to adapt to different data distributions.

The technology has been licensed to digital content management start-up Thothe Technologies Pte Ltd, where it is used to speed up queries on image databases.



The iDistance scheme for a 2-D dataset. Points in the 2-D space are organised into clusters by the reference points (S1, S2, etc). Each cluster is transformed into a single-dimensional region. A query in the 2-D space (green circle) is mapped into a range query in the 1-D space.

Total cohesive failure is shown in the peel adhesion test of a commercial sealant to concrete after 28-day immersion in 70°C water.



Perfect cohesion and adhesion shown on the heat-resistant polyurethane sealant.

Heat-Resistant Sealant

Novel compound able to withstand hot and wet tropical climate.

Polyurethane is a high-performance sealant widely used in the joints of pavements, walls and floors. However, it is susceptible to environmental factors such as heat, moisture, ultraviolet rays and others, which affect the performance of the material in the process of curing as well as during long-term exposures. In the tropics, the material also tends to fail prematurely if exposed excessively to the combination of heat and water.

Assoc Prof Michael Chew from the NUS **Department of Building** has formulated a **Heat and Hot Water Resisting Polyurethane** that is highly resistant to heat and can withstand immersion in hot water. The novel two-component polyurethane prevents water-swelling, water-absorption and hydrolysis. The material increases the thermal stability of a seal and enhances adhesion to a porous material, such as concrete, in hot water or under the conditions of a warm and humid atmosphere. The composition includes a hydrophobic polyether diol, which is a cross-linker and an antioxidant, and a polyisocyanate as a curing agent. The first ingredient is a novel hindered amine antioxidant that enables the sealant to resist oxidative damage.

This sealant has commercial application in areas requiring sealant with high resistance to heat and hot water immersion such as pavements, building facades and other civil engineering works.

Nanostructure-Coated Radiation Detector

Patented technology can detect X-rays, electrons and ions, compared with other approaches that are unable to detect all three.

Detectors for X-rays, ions and electrons play an important role in both science and industry. Researchers at the **Singapore Synchrotron Light Source** (SSLS), led by Dr Marian Cholewa, have been working with several groups in Singapore and South Korea to build better radiation detectors based on newly developed nanomaterials. The SSLS team managed to find a fresh approach to detect electrons, ions and X-rays by measuring secondary electrons generated by primary radiation from the heterostructures of zinc oxide nanoneedles coaxially coated with aluminium nitride or gallium nitride. The **Radiation Detector Having Coated Nanostructure and Method** is almost 100 percent efficient and has a high speed of more than 10MHz counting rate and has position sensitivity.

The patented technology can be applied to improve the efficiency and performance of various scientific instruments such as high-speed counting systems (e.g. beam monitors), Secondary Ion Mass Spectroscopy systems, Time-of Flight systems, Proton-Beam Induced X-ray Emission systems and other radiation-based systems.

Reversible Hydrogen Storage in Fuel Cell

Novel system opens up new possibilities for materials development and energy alternatives.

An ever-increasing demand for a sustainable, environmentally friendly source of energy is spurring research in hydrogen as a “green” fuel source. Among the technical barriers, on-board hydrogen storage for fuel cell vehicles and portable devices is the most challenging. Presently, no existing system can meet the practical requirements.

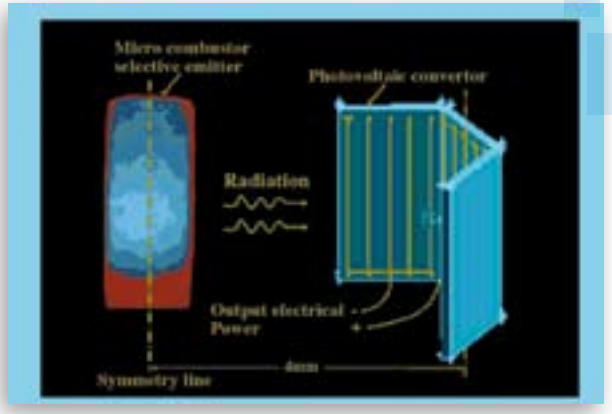
Dr Chen Ping and her team at the NUS **Department of Physics** discovered a novel system named Metal-N-H. Compared to conventional metal hydrides, the material, e.g. Li_3N, could reversibly store about three times more hydrogen. The patent for **Method for Reversible Storage of Hydrogen and Materials for Hydrogen Storage** has been granted. The work, highlighted in *Nature*, also attracted the interest of institutes around the world and industry players such as General Motors, Ford, Toyota and General Electric to further research based on the work.

Team members of the hydrogen storage research: (from left) Dr Chen Ping, Dr Wu Guotao, Dr Liu Yongfeng, Dr Xiong Zhitao and Dr Hu Jianjiang.

Micro-Thermo Power Generator

Invention delivers electric power of 0.5–10W (equivalent to 6 AA batteries in Watts) in a tiny package the size of a hand phone battery.

A micro-thermophotovoltaic (micro-TPV) system is a novel micropower generator. The system comprises mainly a microcombustor/emitter, a filter, a photovoltaic cell array and cooling fans. Photovoltaic cells are semiconductor materials that generate an electric current when irradiated with infra-red photon. A team lead by Prof S K Chou of the NUS **Department of Mechanical Engineering** has developed a **Micro-Thermo Power Generator** that is smaller than existing devices but produces more power. The new invention has a thermally integrated microcombustor/emitter and a converter. Chemical energy stored in fuel is converted into heat energy in the burner through microcombustion, and the heat energy is converted into electrical power by a photovoltaic cell array. Compared to conventional batteries, the micro-TPV has a much higher power density.



Schematic of a micro-thermophotovoltaic power generator.

Different from other micropower generators such as microengines, this system has no moving parts and as a result, it is more durable and can be used as a power source of a range of micromechanical systems. It is simple in design, rugged in construction and economical to manufacture. The patented system has much potential for application in personal and portable power.

Commercialisation

Polymer Optical Fibre Vibration and Liquid Level Sensor Kit

Optical fibre sensor educational kit allows students to have hands-on experience of a variety of engineering subjects such as basic optics, vibration theory, electronic devices and signal acquisition.

An optical fibre sensor educational kit, which can be used to capture the vibration response of a beam and to detect water level is now available in the market. The plastic-based optical fibre sensor for crack and vibration monitoring of structures uses polymer-type fibres which are much easier to handle. Zugo Photonics Pte Ltd, a regional distributor of photonic products, approached the creators Dr Kevin S C Kuang and Prof Quek Ser Tong from the NUS **Department of Civil Engineering** to commercialise the design developed by them.

Targeting pre-university-level students, the kit is the first Singapore-developed optical fibre sensor marketed by Zugo Photonics. It includes a comprehensive set of instructor-student manual, authored by Dr Kelvin Kuang, that serves to inculcate inter-disciplinary learning.

The simple design makes it a highly affordable system, yet offers good measurement capability. Ngee Ann Polytechnic, Hwa Chong Institution and Gan Eng Seng Secondary School in Singapore, as well as Universiti Teknologi MARA, Malaysia, are already using the kits.

Optical fibre sensor educational kit.

Real-Time Shadow Generation Software for Computer Animation

New shadow map technique, termed trapezoidal shadow maps, set to enhance realism of training and simulation software, even the gaming experience.

Invented by Assoc Prof Tan Tiow Seng and his graduate student from the NUS **Department of Computer Science**, the method enables the calculation of high-quality shadows in real-time applications. It addresses the aliasing problem of standard shadow maps in a novel way by approximating the camera frustum seen from the light's view with a trapezoid. High-quality shadows are generated for all large, small, curved and sharp objects, as well as for objects near and far away from the light sources. The technique generates shadows for both dynamic and static objects without the annoying flickering effect in all existing approaches. In addition, it efficiently computes trapezoids, independent of scene complexity, to address the so-called continuity problem where shadows appear and disappear. This problem occurs in current methods when the shadow map quality changes drastically from frame to frame due to the change in eye's view.

The method is simple to implement without using complex data structures. It maps well and executes efficiently in graphics hardware without consuming much computing resources. Possible applications include computer games to generate quality shadow; urban planning software to generate shadows on the fly for the different sun's positions in urban planning studies; and visual simulators to enhance the realism of training and simulation software.

The invention has been implemented and tested. Big Huge Games Inc in the US has incorporated the technology into its game engine.

Top: The TMSI acoustic modem operation is via a laptop graphical user interface.

Right: Dr Mandar Chitre (left) and lab officer Mr Mohan Panayamadam deploying the "wet-end" of the acoustic modem.

Acoustic Modem Tunes up Shallow-Water Communication

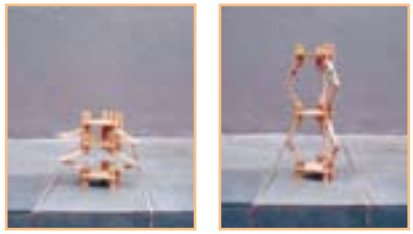
Trials confirm that the new approach achieve an order of magnitude improvement over existing commercial acoustic modems in local waters.

Wireless communication underwater is important for marine operations. However, radio communications fail at very short distances in the sea compared to air because seawater rapidly absorbs the electromagnetic waves. Acoustic, or sound, waves are both slow and multiply-reflected from the surface and bottom of a shallow water environment, which can also be very noisy, making acoustic communications underwater even more difficult. While considerable progress has been made in the development of deep water systems, commercial off-the-shelf solutions fail miserably in warm shallow waters.

Dr Mandar Chitre of the Acoustic Research Laboratory in the **Tropical Marine Science Institute** identified the cause of this dramatic failure and developed a unique encoding system to overcome the problem. The difficulty lies in the non-Gaussian noise characteristics of warm shallow waters, dominated by impulsive "clicks" from small shrimp. Dr Chitre has created models for the shallow-water communications channel and optimisation codes based on a class of non-Gaussian noise models. This opens the door to developing effective ad-hoc networks for autonomous intelligent assets to communicate while surveying the marine environment, a key capability for both defence and commercial marine operations. The researchers have filed a patent for the underlying principles. Singapore Technologies has licensed the technology for defence applications.

Rapid Tension-Strut Structures

Structures useful in areas such as exhibitions, emergency services and military services.



Deployable Tension-Strut Structure prototypes.

Led by Assoc Prof Richard Liew, a team at the NUS **Department of Civil Engineering** has developed Deployable Tension-Strut Structures (DTSS) that allow fast, safe and lower-cost installation of shelter structures. Many prototypes in wood, plastic, aluminium and structural steel have been built to assure that the proposed DTSS can offer the advantages for economical and efficient deployment. A patent has been filed for the technology and a start-up company VRich Technology has been formed to commercialise it.

Eco-Friendly Way to Detect and Eradicate Bacteria

Cloned proteins from horseshoe crab used in sterility tests and microbe removal.

Novel biomolecules present in the blood of horseshoe crabs are used as an effective rapid detection system for Gram-negative bacteria (GNB) in the pharmaceutical industry. However, the animal has been heavily harvested and its population is swiftly declining. To address the dire situation, Prof Ding Jeak Ling from the NUS **Department of Biological Sciences** and Assoc Prof Ho Bow from the NUS **Department of Microbiology** have cloned the gene coding for the clotting enzyme used in the detection of GNB. This reduces the need to harvest the animal for research or industrial purpose, thereby helping to preserve the horseshoe crabs.

The two researchers developed recombinant protein (rFC) that allows the rapid and efficient removal of GNB and lipopolysaccharides (LPS). They further derived Sushi peptides from this recombinant protein that have antimicrobial activity against multiple antibiotic-resistant GNB. Both the patented rFC and the Sushi peptides have been licensed to US biotechnology companies for diagnostic and LPS removal applications. Cambrex Inc and BioDTech Inc have been awarded exclusive worldwide licences to use and further develop the patented technologies to market quick, user-friendly sterility test and LPS-removal strategies, respectively, for parenteral fluids and medical equipment. The products are currently available commercially.

Rapid Dengue Test Kit

New polymerase chain reaction (PCR) test kit can now confirm whether a person has dengue within 3–5 days instead of the usual 8 days by current methods.

Veredus dengue test kit.

Assoc Prof Vincent Chow from the NUS **Department of Microbiology** has developed primers that kick-start the process of PCR amplification of dengue viruses. The highly specific primers allow the confirmation of the dengue virus type and can detect very low copy numbers of dengue virus per unit volume of blood sample. The patented technology has been commercialised by Singapore biotech start-up Veredus Laboratories into a rapid-test PCR kit called Vereden.

Existing dengue immunodiagnostic tests measure the antibodies induced by the dengue virus, and the result is usually negative until after a fever develops. On the other hand, the PCR kit employs nucleic acid-based testing which can be potentially used to confirm dengue within 3–5 days of fever by detecting the circulating virus in the blood. Current immunological tests only start becoming positive towards the end of the viraemic phase, namely beyond day 7.

The PCR assay, which takes several hours, can also identify which of the four different types of dengue virus a person has contracted. Together with newly designed primers from NUS, the existing primers can be adapted to develop new test kits for Japanese encephalitis, West Nile and yellow fever viruses that are prevalent in many parts of the world.

Spin-Offs

BioMers Pte Ltd

www.biomersbraces.com

Smile goodbye to unsightly braces with almost invisible ones designed by researchers from NUS. PhD candidate Ms Renuga Gopal from the NUS **Department of Mechanical Engineering** and former research assistant Ms Karen Teo from the NUS **Department of Restorative Dentistry** have developed technologies that can make aesthetic braces with properties necessary to straighten teeth. These are better than existing products that are not suitable for every degree of tooth crookedness and which often lack the mechanical properties to straighten teeth effectively.

The duo have filed patent for the new process to fabricate fibre-reinforced composites that permit arch wire production. This platform technology can be expanded to create high-strength composite structures for applications like fasteners. Another patent-pending fabricating system allows the development of brackets strategically reinforced in critical regions. The result is an aesthetic, mechanically rigid product that is not abrasive when compared to current ceramic brackets. The arch wires and brackets form the first completely translucent braces system in the market.

The researchers have spun off BioMers, together with Dr Mervyn Fathianathan from the NUS **Department of Mechanical Engineering**, to market the braces. Orthodontists can easily adopt the invention as it functions similarly to conventional metal braces. The start-up also plans to offer polymer composite products for applications in dentistry and orthopaedics.

Top: BioMers' new transparent braces look almost invisible.

Left: BioMers founders: (from left) Ms Karen Teo, CTO; Ms Renuga Gopal, head of R&D; and Dr Mervyn Fathianathan, CEO.

BioNano founders: (from left) Dr Ye Jian-Shan, Assoc Prof Lim Tit Meng and Assoc Prof Sheu Fwu-Shan.

BioNano International Singapore Pte Ltd

www.bionano.com.sg

Few companies in Singapore offer nanotechnology products despite the field being a hot research area. Scientists at NUS have translated their research in electrochemical biosensors into applications, and set up a company to market the products.

Assoc Prof Sheu Fwu-Shan, Dr Ye Jian-Shan and Assoc Prof Lim Tit Meng from the NUS **Department of Biological Sciences** spun off BioNano International Singapore to commercialise novel biosensors using multi-walled carbon nanotubes. The nanotubes have special properties such as high electrical conductivity and chemical stability, as well as high mechanical strength and modulus. The patented technologies accrue beneficial attributes to the development of chemical sensors and biosensors, which the researchers put to good use. They have designed biosensing and analytical instruments for research and industrial applications, as well as solid-state pH probes and integrated electrochemical workstations. The probes are more durable, safer and not easily contaminated when compared to existing probes with glass electrodes. The electrochemical workstation provides a platform on which applications can be developed depending on the sensors used. A patent-pending glucose sensor built with aligned multi-walled carbon nanotubes allow fast, highly sensitive, low-potential and stable detection of glucose. This holds promise as devices for the food industry and diabetic patient blood sugar monitoring.

BioNano is also designing customised education packages for teaching nanotechnology, and has conducted courses for Jurong Junior College that were well-received. The workstation can be used as a learning tool to do research in life and environmental sciences.

ByteSquare Technology Pte Ltd

www.bytesquare.com

The explosion of data available on the web, coupled with the increased number of Internet-enabled hand phones, shows that mobile data communication and services will experience strong growth in the near future. A group of engineering students envisages a future where such services will become prevalent and have come up with solutions to address the need.

The NUS **Department of Electrical and Computer Engineering** team has developed a data communication framework between the web and mobile interfaces. Essentially a data translation pipe, this system and method for mobile email employ a number of innovations. The Mobile Image Optimisation Algorithms ensure good image quality on mobile devices by reducing data redundancies. The SMS/MMS/WAP gateway solutions and applications cater to mobile commerce, advertising purposes and individual needs. The implementation and development of Over The Air (OTA) data acquisition and optimisation techniques provide secure and reliable network linkage

The inventors have spun-off ByteSquare Technology to tap on their patented technology to build enterprise mobile products. WapSquare for mobile messaging and MobileIris for mobile vision are already available in the market, while solutions for mobile content management, blogging and mobile email are in the pipeline. The company is targeting brokerage and advertising industries around the region that reach out to large number of free users. The products will also appeal to service-based operators, telecommunications companies and service providers to large enterprise users.

The founders are currently looking for partners and venture capitalists to maximise the value of their intellectual properties and products.

ByteSquare founders: (from left) Mr Ong Jun Da and Mr Ong Kok Choong with their first server.

Left: A screenshot of Genometri's programme.

Bottom: Bottle designs generated by Genometri's Genoform.

Genometri Pte Ltd

www.genometri.com

In an increasingly competitive world, companies need to do rapid product development to stay viable. Design is a key differentiator that makes or breaks a product. To speed up the process, an NUS spin-off is offering design-generation software that helps create a whole range of designs within a short time.

Adjunct Assistant Prof Sivam Krish, when attached to the NUS **School of Design and Environment**, noticed students spending long hours exploring design options, and he hit on the idea of automating some of the process. He developed and filed a patent for software relating to design generation, which allows the creation of thousands of designs based on a generic design within a few minutes. These design drafts can be previewed in photorealistic quality, thus letting companies assess the desirability of the designs accurately.

The researcher set up Genometri in 2005 with funding from NUS Venture Support, the Singapore Economic Development Board and a private investor. Marketed as Genoform, the software operates on top of computer-aided design packages such that designers and engineers can easily modify their work at any stage of the process. Mero Asia Pacific is using Genoform to create metal fitting designs for architectural glazing, and customising them rapidly for clients. British design firm Future Factories is applying the software to design lamps manufactured by rapid prototyping. Singapore jeweller RISIS is another user of Genoform.

Fatte Telecommunications Pte Ltd

www.fatte.com

Technologies that provide value-added services to mobile users while simplifying their mobile life — these are no empty promises as such research at NUS has been translated into applications. Developed by Assoc Prof Hari Krishna Garg from the NUS **Department of Electrical and Computer Engineering**, the patent-pending system and method for providing a service has led to a spin-off firm. The researcher set up Fatte Telecommunications in May 2004 and have recently incorporated the technologies in three solutions — gCross, cMask and gCritical.

Assoc Prof Hari Krishna Garg holding a mobile phone with value-added services from Fatte Telecoms.

gCross enables one to make voice-over-Internet Protocol (VoIP) phone calls from regular mobile or fixed-line phones. cMask is an identity management tool that allows the subscriber to make or receive calls while securing the user mobile identity. It is ideal for on-line community portals with dating themes, people with active social lifestyles and professionals who wish their personal time respected. gCritical lets a person make and receive emergency calls from a regular mobile or fixed-line phone, an important aspect in time of crisis. Potential customers for the solutions are major telecommunications companies and VoIP providers such as Skype, Yahoo and Microsoft.

Integrated Internet and communication roaming service provider GlobalRoam Group Ltd has acquired Fatte Telecoms for its attractive value proposition, as well as licensed the patented technologies from NUS on an exclusive worldwide basis.

Leo6 Technologies Pte Ltd

www.leo6-tech.com

The current Internet protocol IPV4 is moving towards the next-generation IPV6 with better performance. Most IPV6 solutions available in the market today have complex Internet Protocol (IP) addressing scheme, which leads to an increase in wireless devices and hotspots, causing addressing conflicts. Due to the multi-vendor environment, international SMS from mobile phones has to transgress Network Address Translator (NAT) that allows multiple hosts to connect to the Internet and firewall multiple times. The likelihood of messages getting lost is high.

A communication technology developed by a group of NUS **School of Computing** students headed by Assoc Prof A L Ananda promises to address this problem. It holds such good potential that the researchers have spun off a company to commercialise it.

Leo6 Technologies was formed in February 2006 to exploit the patented Twin-Glass technology. The company's plug-and-play solution comprises a single Twin-Glass box that serves an IPV4 sub-net while handling mobile IPV6. It supports Private and Dynamic IP, offers automatic backup and activation, and does not need a NAT. This "transparent" technology allows current IPV4 backbone to scale up to IPV6 seamlessly, promising to solve the transition problem for telecommunications companies (telcos) and organisations when they upgrade to the next-generation network.

As China has mandated the use of IPV6 backbone with the formation of the China Next Generation Internet, there is huge opportunity in the country. Leo6 is targeting Chinese telcos in the country looking for good upgrading solutions. The Twin-Glass technology could help them and large network providers smoothly upgrade their network without affecting the current infrastructure. With funding and support from NUS Venture Support and a private investor, Leo6 has attracted the interest of China Netcom and China Telecom. China Netcom has already completed functional testing for the technology and a large-scale trial run is upcoming.

Routers, servers and prototypes at a test bed for Twin-Glass development.

The world's first mobile scanning electron microscope.

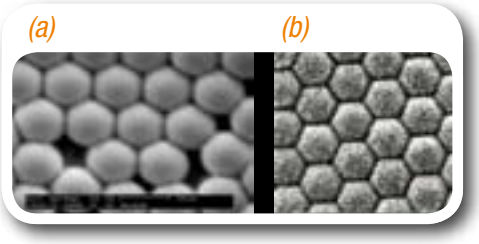
Mini Electron Beam Instruments Pte Ltd

http://sg.geocities.com/nkmebi/

The world's first mobile scanning electron microscope (SEM) was developed jointly by a Czech firm and the NUS **Department of Electrical and Computer Engineering**. Based on input from the company, Assoc Prof Anjam Khursheed and research engineer Mr Nelliyan Karuppiah designed the microscope, which is smaller and cheaper than conventional SEMs.

They have spun off Mini Electron Beam Instruments to make mobile SEMs for research and industry.

The duo have also invented an add-on lens that fits on to the normal specimen stage of a conventional SEM, and is capable of improving the image resolution by more than a factor of three. The specimen is placed inside the attachment, instead of on the specimen stage. The attachment immerses the specimen in a strong magnetic field, effectively shortening the working distance, therefore lowering the aberrations of the final image. The attachment is particularly suitable for operating SEMs at low landing energies (1keV or less), where they improve the image resolution by over a factor of four.



Comparison of images taken with conventional SEM and the mini SEM.

(a) Conventional SEM image of 500nm nanospheres

(b) Mini SEM image of 500nm nanospheres

MXR Corporation Pte Ltd

www.mxrcubes.com or www.mxrcorp.com

Learning the fun way with 3-D interactive contents — this is a revolutionary concept poised to capture children's attention. The idea has also captivated the business community such that Toys "R" Us, Hasbro Inc and Borders have indicated their interest to carry products based on the concept.

The mixed reality proposition — a human–computer interface technology that merges the real and virtual worlds together — is the brain child of MXR Corporation. Founded by Dr Steven Zhou Zhi Ying and Assoc Prof Adrian Cheok from the NUS **Department of Electrical and Computer Engineering**, the university spin-off incorporates technologies developed by the two researchers and their team in the area of mixed reality such as interactive system and method and board game. Three patents have been filed in human–computer interaction, of which one has been granted. The company will be launching its first product at the end of 2006 in Singapore and the US. wlz Qubes, which allows the user to physically interact with the story content while learning and viewing the story from all angles in 3-D, could totally change the way children learn from story books. Besides the major retailers mentioned, collaborations are also in the works with Creative Technologies.

The company set up a China branch in Nanjing in January 2006 and became an officially recognised partner of Microsoft in March 2006. It also plans to establish a US subsidiary later in the year with aid from IE Singapore.

Right: MXR product demo.

Left: MXR animation preview.

A PEM book for children.

A PEM diary.

Personal e-Motion

www.personalemotion.com

Interactive and digital learning is increasingly being employed in education and publication. Prof Sam Ge, Dr Chen Xiangdong and Mr Stanley Han from the NUS **Department of Electrical and Computer Engineering** have developed a real-time interactive 3-D engine that forms the backbone for a set of animation e-Book software tools. The platform is able to efficiently exploit computing power to maximise performance when generating power-intensive animation programs. A patent has been filed for the technology.

The inventors believe such learning tools are the way to go and they show their confidence by privately funding a spin-off Personal e-Motion (PEM). Two founders are now working full-time in the company to commercialise the products.

The PEM Book tools for authoring animation e-books are user-friendly and focus on making content alive. The company intends to popularise the interactive engine as the main development platform and portal for sharing and publishing of new digital media. It is engaging partners in the market to produce children's books and educational text for schools. Several primary schools in Singapore are already using the PEM Books, and many more are evaluating the tools, with positive feedback. Educational technology firm AskNLearn is discussing with the start-up to distribute the products overseas.

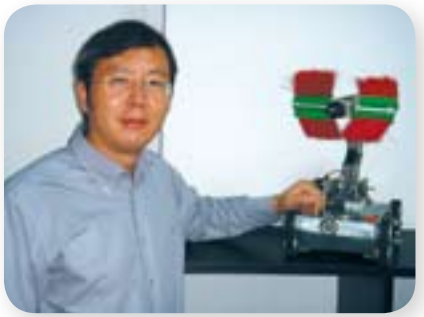
ProTherapeutics

www.protherapeutics.com

ProTherapeutics is Singapore's first biotech company to develop new drugs from proteins, specialising in animal toxins and other natural proteins. Founded by Prof Manjunatha Kini and Assoc Prof Ge Ruowen from the NUS **Department of Biological Sciences**, together with Assoc Prof Peter Wong from the NUS **Department of Pharmacology**, the start-up is the result of a collaboration between Singapore's Bio*One Capital, Exploit Technologies and the NUS Industry Liaison Office. It builds upon a portfolio of intellectual property licensed from Exploit Technologies, NUS and Virginia Commonwealth University.

ProTherapeutics is employing the NUS-patented technique to swiftly locate the protein segment of the King Cobra's venom from the toxic part. Based on the knowledge, the company has developed proprietary technology that allows the optimisation and oral delivery of peptides. It has completed animal efficacy and investigational toxicity studies for the King Cobra's peptide prohanin, which shows strong analgesic effect in animal models for pro-inflammatory pain and neuropathic pain. Prohanin is several thousand times more potent than morphine.

Currently Protherapeutics is working with Aptuit in Scotland and Maccine in Singapore to conduct pre-clinical pharmacology and toxicology studies to enable trial in patients. Orally available anti-angiogenic peptides are currently under development while research on other peptides is being considered.



Mr Xia Qinghua with his cleaning robot.

Robotronics Pte Ltd

www.robotronicsland.com

Robots are useful in performing tasks that are repetitive or that affect the health or safety of humans. One category of robots helps clean places that are dirty or unreachable such as air-conditioning ducts in buildings. However, existing cleaning robots face several drawbacks.

Mr Xia Qinghua, a PhD student under the supervision of Assoc Prof Marcelo Ang from the NUS **Department of Mechanical Engineering**, has developed a new type of duct cleaning robot that is more powerful and efficient in cleaning than current ones in the market. He managed to tackle the various problems and come out with a prototype that is more user-friendly and easier to operate. The invented robot is able to complete cleaning task at one go, cover a larger workspace, climb up steps easily, use fewer accessories, and move easily within the ducts. When tested in an actual air-con duct, the new and more agile robot performed much better than commercial versions. The researchers have filed patents for the technology, and are seeking funding support for commercialisation and marketing.

Mr Xia set up Robotronics with a private investor to make working robots suitable for industrial use. He is collaborating with a few duct cleaning contractors in order to get more feedback on duct cleaning service. Potential customers from Singapore, China, the Philippines, India and Indonesia have expressed interest.

tenCube Pte Ltd

www.tencube.com

Mr Varun Chatterji and three classmates developed an anti-theft software for mobile phones. The patent-pending technology allows users to remotely lock a lost phone and track information such as the number of the new SIM card inserted into the phone. It enables users to recover lost phones, prevent unauthorised calls and protect private data.

By pooling their knowledge in system architecture, mobile development and engineering processes, technology and marketing, the students drew up a business proposition. The viability of the proposal convinced them to set up tenCube at the NUS **School of Computing** Incubation Centre to market the solution. With initial personal funds by the founders, the spin-off now counts the Singapore Economic Development Board, NUS Venture Support and several angel investors as its supporters. It was cited by business consulting firm Frost & Sullivan as one of the Top 10 Wireless Innovations in Asia Pacific.

tenCube's first offerings look at end-user device, data and communication security for Symbian and Windows mobile phones. The researchers are finalising WaveSecure, the first commercial product scheduled for release in late 2006. The solution works on events-based actions triggered by local or remote events such as SMS or web-based pre-defined action. This includes a change in the phone status such as SIM change, mobile device boot-up or addition/editing of information. A default set of security settings that can be easily customised via the web is provided.

The start-up has secured The Enterprise Challenge grant that supports innovation for the public sector. The Singapore Police Force is currently testing out WaveSecure on phones issued to its officers.

tenCube WaveSecure works on the principle of event-based actions, where local or remote events trigger the mobile device to perform a pre-defined action.

RE: CONFERENCES & SYMPOSIA ORGANISED

6

- More than 200 symposia and conferences organised annually
- Confluence for sharing ideas
- Venue for scholarship exchange
- Assembly of knowledge and experience
- Nexus for forging worldwide ties

CONFERENCES & SYMPOSIA ORGANISED

International Conference on Technology and Operation of Offshore Support Vessels (20–21 Sep 2005)

Good demand exists for providing a wide range of support services such as towage, anchor handling, fire fighting, pollution control measures, load-out, transportation and installation activities, and logistics support for offshore oil and gas industry.

The 2-day event organised by the NUS **Centre for Offshore Research & Engineering**, the Joint Branch of the Royal Institution of Naval Architects and the Institute of Marine Engineering, Science and Technology (Singapore), comprised four sessions of technical papers presentations and an experts' panel discussion. It provided a platform for some 180 designers, builders, offshore support vessel owners, operators, drilling contractors and installation contractors to present and discuss future needs and challenges, as the search for hydrocarbons moves into deeper waters.

THINK Logistics — New Frontiers (25–29 Oct 2004)

The Logistics Institute – Asia Pacific organised the event that brought together industry experts, supply chain researchers and supply chain practitioners in a series of presentations and interactive forum discussions. In the week-long programme sponsored by Exel, DHL and BAX Global, participants shared their views and experiences on contemporary challenges and opportunities in the dynamic global logistics industry in an ever-changing world.

Back row: (from left) Prof Charles Liotta, Vice Provost, Research, Georgia Tech; Prof Chelsea White, Executive Director, The Logistics Institute, Georgia Tech; Mr Manohar Khiatani, Director, Transport & Logistics Cluster, Economic Development Board; and Dr Robert de Souza, Executive Director, TLI – Asia Pacific.

Front row: (from left) Prof Jean-Lou Chameau, Provost & VP, Academic Affairs, Georgia Tech; Mr Heng Chee How, Minister of State, Ministry of Trade & Industry; and Prof Tan Chorh Chuan, Provost & Deputy President, NUS.

Mr James Liebertz, President & COO, American Bureau of Shipping, Pacific Division (Singapore) (front row, fourth right) delivered the keynote address at the International Conference on Technology and Operation of Offshore Support Vessels.

THINK Solution Series: Real Time Supply Chain Management II — Logistics ICT in Singapore (30 Mar 2006)

This event organised by **The Logistics Institute – Asia Pacific** was supported by the Agency for Science, Technology and Research and the Infocomm Development Authority of Singapore. The 381-strong audience consisted of senior decision-makers and influencers from a broad spectrum of the logistics industry, technology vendors and agencies. The seminar gave an update of the logistics and infocomm technology (ICT) industry on the latest logistics technologies and showcased Singapore's capabilities in ICT for logistics. A Think-Table Forum was conducted where distinguished thought leaders gave their insights.

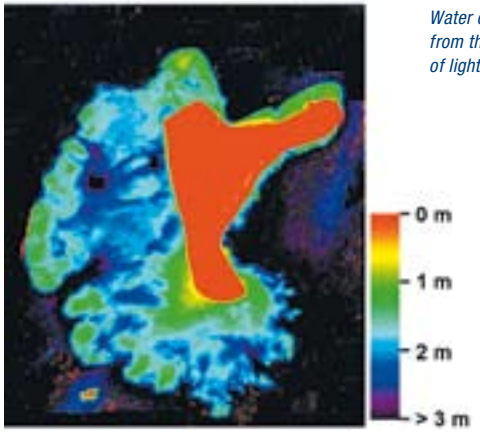
From left: Mr Thomas Yeo, Manager, RFID-FMCG, LHT Holdings; Mr Poon Hong Yuen, Deputy Director, Manufacturing & Services, IDA; Dr John Gan, Senior Research Engineer, SIMTech; Mr George Cavage, Director, Strategy & Technology, APL Ltd; Mr James Loo, CIO, YCH Group; Dr Tin Aung Win, Centre Director, RosettaNet Architecture Centre of Excellence; and Mr Wong Tack Wai, Assistant Director, Defence & Technology, TLI – Asia Pacific.

6th International Conference on Hydroinformatics (20–24 Jun 2004)

The first of its kind in Asia-Oceania, the conference was hosted by the Hydroinformatics Society of Singapore and co-organised by the International Association of Hydraulics Engineering and Research, International Association for Hydrological Sciences and International Water Association. NUS and the **Tropical Marine Science Institute** were part of the Singapore organising committee. The event witnessed a series of development and novel applications of hydroinformatic schemes in wide-ranging fields. It brought together 250 water and environmental managers, engineers and scientists from various disciplines with a common interest in exchanging ideas and experiences in this rapidly developing area.

Ocean Colour Remote Sensing: Methods and Results in Coastal Waters (13 Jul 2004)

Organised by the **Centre for Remote Imaging, Sensing and Processing** and the Naval Research Laboratory of Stennis Space Center, US, the seminar drew some 100 participants. Dr Lee Zhongping, a prominent oceanographer in the Naval Research Laboratory, talked about the fundamentals and application of semi-analytical algorithms on ocean-optics models and remote-sensing algorithms for the retrieval of water bio-optical properties. The event helped the two centres to establish contact and collaboration, and introduced ocean colour research and applications to interested scientists in Singapore.



Water depth of the submerged reefs can be derived from the satellite image by modelling the interaction of light with water and the sea bottom.

Prof Bernard Tan (front row, centre), Chairman of CRISP, and Mr Kwoh Leong Keong (front row, fourth right), Director of CRISP, with participants of the workshop.

3rd Integrated Environmental Monitoring (IEM) Workshop of the Asia-Pacific Region (9–11 Dec 2004)

The **Centre for Remote Imaging, Sensing and Processing** co-hosted the workshop with the National Institute for Environmental Studies of Japan, Commonwealth Scientific and Industrial Research Organization (CSIRO) of Australia and the Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, China. It reviewed the development of the MODIS data receiving stations in the integrated environmental monitoring (IEM) network, examined the progress made in the integration of satellite and ground-based systems for environmental monitoring, as well as the application of IEM in the monitoring and modelling of environmental degradation, disasters and ecological processes.

Country representatives from Australia, China, India, Japan, Mongolia, Russia, Vietnam and Singapore attended this workshop to exchange notes on their research methodology and results on the use of remote sensing in environmental monitoring.

3rd International Conference on Materials for Advanced Technologies (ICMAT 2005) (3–8 Jul 2005)

The 3rd ICMAT, organised by Materials Research Society of Singapore, in association with NUS, Nanyang Technological University and Institute of Materials Research and Engineering, saw more than 2,000 participants representing over 40 countries converging in the Lion City. Held in conjunction with the biennial event was the International Union of Materials Research Societies' 9th International Conference on Advanced Materials (IUMRS-ICAM). A total of 25 technical symposia, 9 plenary lectures and exhibition covered a range of contemporary topics of importance for the science, engineering and technology of the materials.

Three Nobel Laureates – Carl Wieman, Steven Chu and Roald Hoffmann – graced the occasion as plenary speakers at the conference. They also gave public lectures as part of NUS' centenary celebration.

The **Faculties of Science and Engineering** organised a number of symposia focusing on various aspects of materials research and advances. The Electromagnetic Materials symposium hosted by **Temasek Laboratories@NUS** provided an international forum for scientists and engineers to report latest research findings, to exchange ideas and information, and to establish research links.

The NUS Centennial Nobel Laureate Lecture Series Dinner, hosted by President Shih Choon Fong on 5 Jul 2005: (from left) Prof Liew Ah Choy, Director, International Relations Office; Assoc Prof B V R Chowdari, Chairman of the Conference; NUS President Prof Shih Choon Fong; Prof Carl Weiman, Nobel laureate; Mr Wong Ngit Liong, NUS Council Chairman; Prof Steven Chu, Nobel laureate; Prof Roald Hoffmann, Nobel laureate; and NUS Provost Prof Tan Chorh Chuan.

From left: NUSNNI Co-Directors, Prof Seeram Ramakrishna and Prof Andrew Wee having a light moment with keynote speakers Dr Christian Joachim and Prof Daniel Morse.

1st Nano-Engineering & Nano-Science Congress 2004 (7–9 Jul 2004)

NUS Nanoscience and Nanotechnology Initiative (NUSNNI) and **Faculty of Engineering** co-organised the congress to explore the frontiers of nanotechnology, focusing on the integration of nanoengineering, nanoscience, nanomedicine and nanobiotechnology for creative applications on optimal conversion of natural resources for the benefit of society. The premier event in Singapore, which saw 150 scientists from 22 different countries, coincided with the launching of NUSNNI. Topics covered addressed the state-of-the-art subjects of nano-scale research, processes and applications.

Japan-Singapore Joint Symposium on Nanoscience and Nanotechnology (1–4 Nov 2004)

NUS Nanoscience and Nanotechnology Initiative and Japan Society for the Promotion of Science co-organised the symposium centred around the themes "Synthetic and Self-Assembly Approaches to Nanostructures and Bionanotechnology", "Magnetic, Electronic and Photonic Nanostructures" and "Nanopatterning and Nanocharacterization". The event served as a platform for Japan and Singapore researchers to present and exchange their latest achievements in nano-related areas.

First row: (from left) Guest-of-honour, Prof Chew Yong Tian, Deputy Director, Office of Research; Dr Suresh Valiyaveettil (NUS Co-Chair), Department of Chemistry, NUS; Prof Susumu Kitagawa (JSPS Co-Chair), Kyoto University; and Prof Andrew Wee, Co-Director, NUSNNI.

Korean–NUS Bionanotechnology Symposium (11 Jul 2005)

Jointly organised by **NUS Nanoscience & Nanotechnology Initiative** (NUSNNI) and BioNanotechnology Center, Pohang University of Science and Technology in Korea, the symposium brought together scientists from the two universities to share their findings and research in nanotechnology. Presentation included use of carbon nanotubes for biological and electrochemical systems, and nanoparticles for biomedical applications. The Korean visitors toured NUSNNI laboratory and Biopolis to have a better idea of the research undertaken in Singapore.

Dr Joon Won Park (Co-Chairman) led the Korean delegation from Pohang University of Science and Technology, Korea.

International Conference on Advances in Network Sciences (ICANS 2005) (29 Jun–1 Jul 2005)

ICANS 2005, jointly organised by **Temasek Laboratories@NUS**, US Army Research Laboratories and the Singapore Defence Science and Technology Agency, focused on Network Science. It brought together three different communities of the Pacific Rim — namely, nanoscience, biology and computer science — to share and cross-pollinate ideas on Network Science to enhance military operations in a networked environment. Technical papers were presented on the new developments and knowledge in the research areas, with participants from industry, research institutes, academia and government organisations.

International Conference on Image and Video Retrieval (20–22 Jul 2005)

The conference organised by the NUS **School of Computing** provided an international forum for the discussion of research challenges and the exchange of ideas among researchers and practitioners in image/video retrieval technologies. It addressed innovative research in the broad field of image and video retrieval.

ACM Multimedia 2005 (6–11 Nov 2005)

Organised by the NUS **School of Computing**, the premier technical conference drew 354 international researchers from both academia and industry. The programme covered different aspects of multimedia computing; from underlying technologies to applications, theoretical foundations to experimental systems, and servers to networks to devices.

Mr Yutaka Tanaka, Executive Research Engineer, Science and Technical Research Laboratories NHK (Japan Broadcasting Corporation) delivered a keynote address on the future of home media at the ACM Multimedia 2005.

IEEE 2005 Conference on Field-Programmable Technology (11–14 Dec 2005)

This was one of the top conferences in field programmable technology as embedded technologies become widely accepted and deployed. Organised by the NUS **School of Computing**, the event provided the opportunity for professionals, engineers, academics and industrial people worldwide to share new research on the technology and use of field-programmable devices for high performance and/or low energy computation.

First Singapore Mini-Symposium on Medicinal Chemistry: Advances in Synthesis and Screening (6 Jul 2005)

The Medicinal Chemistry Program established under the Experimental Therapeutics Platform of the NUS **Office of Life Sciences** is a multi-disciplinary initiative involving departments in the **Faculty of Science** (Chemistry, Pharmacy, Biological Sciences), **Yong Loo Lin School of Medicine** (Pharmacology) and **Faculty of Engineering** (Chemical and Biomolecular Engineering). It aims to establish Singapore as a centre for medicinal chemistry research, promote collaborative research between academia, research institutes and pharmaceutical companies, as well as train manpower.

The Program hosted the inaugural Mini-Symposium on Medicinal Chemistry with the theme “Advances in Synthesis and Screening”. The speakers were Prof Hisakazu Mihara (Tokyo Institute of Technology), Prof Injae Shin (Yonsei University), Prof Lam Yulin (Medicinal Chemistry Program, Department of Chemistry, NUS), Prof Itaru Hamachi (Kyoto University), Prof Yoshinobu Baba (Nagoya University) and Prof Martin Lear (Medicinal Chemistry Program, NUS). A poster session of about 30 contributions was held concurrently.

4th Asian Mathematical Conference (AMC 2005) (20–23 Jul 2005)

AMC was initiated by the South East Asian Mathematical Society (SEAMS) as a platform to showcase talents from Asian countries and to encourage academic exchange within the region. The 4th AMC, held in conjunction with the centennial celebrations at NUS, was jointly organised by the NUS **Departments of Mathematics** and **Statistics and Applied Probability**, the **Institute for Mathematical Sciences**, Singapore Mathematical Society and SEAMS. Topics covered included Algebra and Group Theory, Mathematics Education, Lie Theory and Operations Research.

Speakers and committee members of the 4th Asian Mathematical Conference.

The 10th Conference on Theoretical Aspects of Rationality and Knowledge (10–12 Jun 2005)

The conference was co-organised by the NUS **School of Computing** as part of the Uncertainty and Information in Economics programme hosted by the **Institute for Mathematical Sciences**. The talks and papers presented dealt with the inter-disciplinary issues involving reasoning about rationality and knowledge, and demonstrated a broad and deep collaboration among researchers from a wide variety of fields such as mathematics, computer science, economics, linguistics, philosophy and psychology.

Participants of the 10th Conference on Theoretical Aspects of Rationality and Knowledge.

International Conference on Wavelet Theory and Applications: New Directions and Challenge (10–13 Aug 2004)

Organised by the **Institute for Mathematical Sciences**, University of Wisconsin-Madison and Brown University, the conference aimed to promote research interest in wavelet and approximation theory and their application in image and signal processing, and to foster collaborations and exchanges among researchers. The meeting part of a big programme — Mathematics and Computation in Imaging Science and Information Processing — emphasised the discovery of new multi-disciplinary directions and the major challenges in the field from both theoretical and application point of view.

Singapore International Chemical Conference 4 (SICC 4) (8–10 Dec 2005)

Jointly organised by the divisions of Chemistry and Biological Chemistry of Nanyang Technological University, the NUS **Department of Chemistry** and the Singapore National Institute of Chemistry, the biennial event sought to raise the profile of chemical sciences in Singapore. The conference, fourth in the series, discussed the significant scientific developments in molecular synthesis and catalysis, as well as new ideas and trends in the 21st century.

6th Sino–Singapore Symposium on Biology (11–12 Nov 2005)

The symposium served as the venue for eight Chinese universities and the NUS **Department of Biological Sciences** to present the work of young scientists from both countries, with the possibility of research collaboration. Nankai University, Wuhan University, Tsinghua University, Peking University, Shanghai Jiao Tong University, University of Science and Technology of China and Fudan University meet every year to exchange research findings and to form networks between the universities.

The Singapore group was led by Prof Hew Choy Leong, Head of Department of Biological Sciences (front row, centre) and was joined in Fudan by delegations from eight Chinese universities.

12th International Conference on Biomedical Engineering (ICBME) (7–10 Dec 2005)

The ICBME is a series of biennial international conferences in biomedical engineering held in Singapore. Jointly organised by the Biomedical Engineering Society of Singapore and the NUS **Faculty of Engineering** and **Yong Loo Lin School of Medicine**, the Conference attracted almost 700 doctors, bioscientists and bioengineers globally. Besides plenary lectures by renowned speakers, 19 symposia ranging from tissue engineering and medical diagnostics to reproductive bioengineering were held.

From left: Assoc Prof James C H Goh, Co-Chair ICBME2005; Prof Chew Yong Tian, President Biomedical Engineering Society (Singapore); Prof Shu Chien, keynote speaker, University of California San Diego; Prof Tan Chorh Chuan, NUS Provost; and Assoc Prof S L Toh, Chairman ICBME2005.

1st Singapore Lipid Symposium (17–19 Feb 2006)

Lipid research has gained from a number of recent achievements and developments. First, genetic and cell biological research has provided new insights into molecular mechanisms of lipid action. Second, deregulated lipid metabolism plays an important role in many human diseases, in addition to obvious presentations such as diabetes. Third, novel analytical approaches of lipids are being developed at a very rapid pace. Convergence of these developments will thus open new opportunities in drug and biomarker development, at both non-clinical and clinical stages.

This inaugural symposium, organised by the NUS **Department of Biochemistry** and Singapore's Institute of Molecular and Cell Biology, aimed to spur this process by bringing together investigators with diverse backgrounds in lipid research. Internationally renowned cell biologists, biochemists and biophysicists presented their latest research advances and had a round table discussion to distill the various topics.

30th Annual Meeting of the International Society of Paediatric and Adolescent Diabetes (3–6 Nov 2004)

The NUS **Department of Paediatrics** chaired the organising committee for the meeting hosted by the International Society of Paediatric and Adolescent Diabetes. Held for the first time in Singapore and the second time in Asia, the focus was on the growing metabolic problems facing adults, such as impaired glucose tolerance and diabetes that originate in childhood. Highlights of the event included: lectures and symposia on treatment of diabetes; the consequences of childhood obesity; vascular problems in childhood diabetes; neonatal diabetes; as well as workshops

on hypoglycaemia, diabetes education in different cultural contexts, diets, and better diabetes control. More than 500 doctors, nurses, dieticians, psychologists, nurses and social workers dedicated to the work for children with diabetes attended the meeting.

2nd Singapore International Neuroscience Conference (22–23 Jul 2004)

The National Neuroscience Institute and NUS **Yong Loo Lin School of Medicine** jointly hosted the event to showcase both organisations as centres of excellence for neuroscience research in Asia and to stimulate greater interest in such research in Singapore. An international panel of world renowned neuroscientists came together to discuss various aspects of brain function and dysfunction. The theme "Mechanisms, Models and Medicine" looked at disorders afflicting the brain and nervous system. It reflected the progression of efforts to translate bench discovery into bedside therapies. The biennial conference successfully bridged multi-lateral collaborations between local and overseas researchers.

3rd World Congress of Nephrology (26–30 Jun 2005)

The congress was organised by the Singapore Society of Nephrology, International Society of Nephrology and the Asia Pacific Society of Nephrology. Chaired by NUS **Yong Loo Lin School of Medicine**, the event attracted a big turn-out of 4,500 delegates. The congress focused on "bench to bedside", addressing cutting-edge kidney research, as well as diagnostic and therapeutic aspects of renal disease. The programme was designed to allow participants to improve their understanding of the relationships between basic research and clinical applications in the field of nephrology and related areas, as well as managing the progression of kidney disease worldwide.

4th World Melioidosis Congress (16–18 Sep 2004)

Held once every three years, the 2004 event was organised by DSO National Laboratories, the Biomedical Research and Experimental Therapeutics Society of Singapore, the Singapore Society for Biochemistry and Molecular Biology, the Singapore Society for Microbiology and Biotechnology, and the Singapore Infectious Diseases Society. The NUS **Department of Microbiology** was part of the Singapore organising committee. As melioidosis has a mortality rate of between 30 to 40 percent, there is a pressing need to improve diagnosis, laboratory investigations, preventive measures and management of patients. Experts exchanged their insights into topics including clinical experiences and treatment protocols, vaccine development, epidemiological studies, molecular studies on pathogenic mechanisms (how the bacteria cause diseases) and diagnostics.

8th World Congress on Down Syndrome (14–18 Apr 2004)

Singapore won the honour of being the first Asian venue to host the World Congress on Down syndrome. The event, held once every four years, drew over 800 participants from 34 countries. The NUS **Department of Obstetrics and Gynaecology** was involved in the scientific committee organising the Congress Programme. For the first time, the Congress was separated into two parts. Part I dealt with Medical and Scientific issues; and Part II was on Main Congress. Another innovation was the Merlion Experience that allowed individuals with Down syndrome as well as parents, care-givers, professionals and service providers to come together as a group through their own special programme. The event received good feedback and successfully shared cutting-edge developments and information from specialists in the field to improve the quality of life for individuals with Down syndrome and their families.

2nd Asian Regional Dengue Research Network Meeting (28–30 Sep 2005)

Dengue has been re-emerging with renewed force in the region and causing great concern. The 2nd Asian Regional Dengue Research meeting held in Singapore was thus timely, especially for Singapore, which saw record cases of dengue in 2005. Organised by the International Association of Pediatric Laboratory Medicine and the Singapore Association of Clinical Biochemists, the NUS **Department of Microbiology** chaired the congress which focused on the latest scientific and technological achievements on all areas of paediatric clinical and diagnostic laboratory medicine. The theme "Strategies for Vaccines and Therapeutics for Dengue and other Flaviviral Diseases" included diagnostics in childhood malignancy, infectious disease testing, infant to adolescent endocrinology, and neonatal medicine. The event attracted over 400 delegates from around the region.

2nd Asian Regional Dengue Research Network meeting attracted over 400 delegates from the region.

2nd SERI-ARVO Meeting on Research in Vision and Ophthalmology (16–19 Feb 2005)

The Singapore Eye Research Institute, which is affiliated to the NUS **Department of Ophthalmology**, hosted the meeting of the Association for Research in Vision and Ophthalmology. The **Department of Community, Occupational and Family Medicine** was also part of the organising committee. The meeting received an overwhelming 526 abstracts and attracted more than 700 attendees from 36 different countries. A total of 148 symposium presentations addressed the important clinical and translational aspects of vision and ophthalmic research. ARVO, the largest vision and research organisation in the world, presented a special symposium on "Hot Topics in Eye and Vision Research".

Singapore National Eye Centre 15th Anniversary International Meeting (3–5 Sep 2004)

The NUS **Department of Ophthalmology** was in the organising committee that hosted the meeting. With the theme "Clear Vision for All Ages", the scientific programme featured symposia, updates, master classes, skill transfer courses and live surgery demonstration presented largely by Singapore ophthalmologists. Renowned experts from all over the world were also invited as speakers. The meeting uncovered new and significant advances from major sub specialties that would impact the practice of ophthalmology.

5th HUGO Pacific Meeting & 6th Asia-Pacific Conference on Human Genetics (17–20 Nov 2004)

The 5th Human Genome Organization meeting was hosted by **NUS** and the Genome Institute of Singapore. The theme of the conference "Genomics Medicine and Population Health" centred on the newest discoveries arising from genomics and population studies pertinent to human disease. It looked at how human migration generated patterns of genetic diversity that was the basis for disease-specific susceptibility traits. The conference examined how genomic approaches are used to identify disease genes, and how new technologies are changing gene discovery and disease genetics. Special sessions included bioinformatics and computational biology. Ethical and legal issues as well as business opportunities for genomics were explored. Dr Tony Tan, then Deputy Prime Minister, delivered the keynote address to a crowd of about 500 scientists, clinicians and academics from around the world.

3rd Asia Pacific Conference and Exhibition on Anti-Ageing Medicine 2004 (24–27 Jun 2004)

The conference, organised by the NUS **Department of Biochemistry**, attracted more than 800 participants worldwide. Themed "Cancer, Brain Ageing, Diet, and Hormones" the event represented the wide scope of knowledge that anti-ageing medicine encompassed. The event provided physician education in the clinical specialty of anti-ageing medicine in the region and emphasised the critical importance of identifying the mechanisms of ageing and age-related diseases to avert the mounting social, economic and medical woes faced by nations the world over.

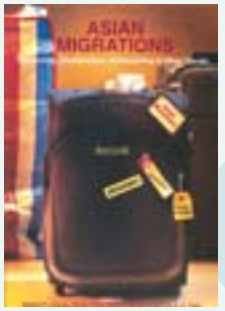
Panel discussion during the Critical Issues Confronting Asia in the 21st Century conference.

Critical Issues Confronting Asia in the 21st Century (16 Mar 2006)

NUS **Faculty of Arts and Social Sciences** and Stanford University's Walter H. Shorenstein Asia-Pacific Research Center (APARC) jointly organised a roundtable discussion on "Critical Issues Confronting Asia in the 21st Century". The event was well-attended by policy makers, faculty members and students who discussed key issues confronting Asia such as migration, ageing, religion and politics. The organisers expected the event to lead to other collaborative ventures in both research and education.

Asian Migrations: Sojourning, Displacement, Homecoming and Other Travels (20 Sep 2005)

The public conference organised by the **Asia Research Institute** addressed the nature of Asian migrations of a wide spectrum of peoples – professional and managerial elites, contract workers, "illegal" migrants, "forced" migrants, and frequent flyers – and its implications for identity, citizenship and notions of "home". The conference aimed to spur the rethink of the links between mobility and place, and the examination of the cultural politics in differentiating the power of mobile and non-mobile subjects.



Asian migration conference led to the publication of a collection of essays exploring migration experiences.

Managing Globalisation: Lessons from China and India (4–6 Apr 2005)

The inaugural conference of the NUS **Lee Kuan Yew School of Public Policy** brought together, for the first time, experts and scholars from the two new giant economies of Asia to debate the challenges and opportunities brought about by globalisation. The event was co-sponsored by the Asia Society of New York and Brookings Institution, in collaboration with the **East Asian Institute** and the **Institute of South Asian Studies** at NUS. The conference tied in with the official opening of the School by Minister Mentor Lee Kuan Yew.

Cultural Diversities and Nation-States in a Globalizing Age (1 Sep 2005)

As part of the NUS Centennial Celebrations, the NUS **Department of Sociology** hosted the international symposium on cultural diversities with presenters from the United States, India, Japan, Germany, China, the Philippines and Myanmar. It drew a crowd of more than 100 guests, faculty and students. Four keynote speakers, Prof Nur Yulman (Harvard University), Prof Ashis Nandy (Centre for the Study of Developing Societies), Prof Hans Georg Soeffner (Konstanz University) and Prof Tomotsu Aoki (Hosei University), gave their views.

Keynote speakers and participants of the symposium on cultural diversities.

Singapore Economic Review Conference (4–6 Aug 2005)

Co-organised by The Singapore Economic Review, NUS **Department of Economics**, Economic Society of Singapore and World Scientific Publishing, the conference covered a wide range of economic issues impinging on Southeast Asia and the broader Asia-Pacific region. It was a forum for discussion and dialogue among 400 international academics, researchers, practitioners, policy-makers and students. Prof Edward Prescott, 2004 Nobel laureate in Economics, gave the keynote address on "Monetary Policy and the Value of the Dollar". Mr Tharman Shanmugaratnam, Minister for Education, opened the conference with an insightful speech.

Mr Tharman Shanmugaratnam (left) having a cordial discussion with Prof Edward Prescott.

Second Annual Conference of Asian Law Institute (ASLI) (26–27 May 2005)

The conference organised by the NUS **Faculty of Law** themed "The Challenge of Law in Asia: from Globalization to Regionalization?" provided a platform for scholars to share legal developments relevant to Asia. Besides discussing a broad range of topics, the 182 delegates from law schools and research institutes from Asia, Europe, North America and Australasia gained an insight of the key developments of law in Asia presented by 12 ASLI Board of Governors.

City as Target (20–21 Aug 2004)

The City as Target International Workshop organised by the NUS **Departments of History** and **English Language and Literature** looked at aspects of urbanism and the military. The workshop was a development of a previous project on Perpetuating Cities, leading to two publications that have received good reviews and cited extensively in many institutions in North America, the United Kingdom and other parts of the world. One is a special issue of Cultural Politics, which has appeared as Volume 2 Issue 1 in early 2006, and the other is a book that is being considered for publication by academic publisher Routledge (NY and London).

Asian Horizons — Cities, States and Societies (1–3 Aug 2005)

To mark 100 years of tertiary education in Singapore, the NUS **Faculty of Arts and Social Sciences** and the **Asia Research Institute** organised an international conference that brought together over 160 local, regional and international experts to reflect on the dynamic transformations of Asian cities, states and societies.

The 3-day conference saw some of the world's top scholars congregating in Singapore to share their insights, perspectives and state-of-the-art research on various facets of the conference theme. These included panels like "Cities and Nations", which discussed the role of the cities in the making of nations, and "Asian Port Cities" that looked at the distinct cultural, social and economic characteristics of Asian port cities. The focus on Asia underscored the Faculty's commitment to achieve excellence in the study of Asia by extending the boundaries of scholarship and knowledge of all aspects of this dynamic and important region.

In her opening address, Guest-of-honour, Dr Aline Wong, Chairman of the Housing and Development Board, spoke about the impact of globalisation on urbanism at the Asian Horizons conference.

3rd Great Asian Streets Symposium (6–8 Dec 2004)

The annual event organised by the NUS **Department of Architecture** catered to urban researchers and professionals studying streets and public places in Asia. The focus topic "Street, Urban Space and Representation" covered a variety of traditional and new representational approaches, which were essential to the practice and research in architecture, urban design and city planning.

Prof Hartmut HäuBermann, Professor of Urban and Regional Sociology at Humboldt University in Berlin, delivered the RC21 presidential address on the "European City: Eurocentric Perspective?"

RC21-NUS Conference: Paths of Urban Change — Social and Spatial Perspectives (9–11 Dec 2004)

The NUS **Department of Real Estate** hosted the Research Committee 21 conference, aimed at promoting research in the sociology of urban and regional development, and to create an international community to advance the field. Subjects discussed included migration and multi-culturalism; inequality, poverty and homelessness; tourism and urban culture; remaking downtowns and real estate; learning cities; mega urban projects; housing and real estate; urban culture; governance; social structure and network; and innovative Singapore.

The Inaugural CLS International Conference CLaSIC 2004 (1–3 Dec 2004)

The conference was the first in a series of conferences organised by the Centre for Language Studies (CLS) at the NUS **Faculty of Arts and Social Sciences** on foreign language teaching and learning. The conference brought together academics, researchers and language professionals from institutions in Asia and other parts of the world to discuss and explore a wide range of key issues that impact foreign language learning and teaching.

The unique multi-cultural and multi-lingual social setting in Singapore also provided an ideal environment to study linguistic and language teaching and learning issues. CLaSIC 2004 reinforced the core strength of CLS and forged closer academic networks with scholars from top institutions. It enhanced the reputation of the Centre and the University beyond the Asian region.

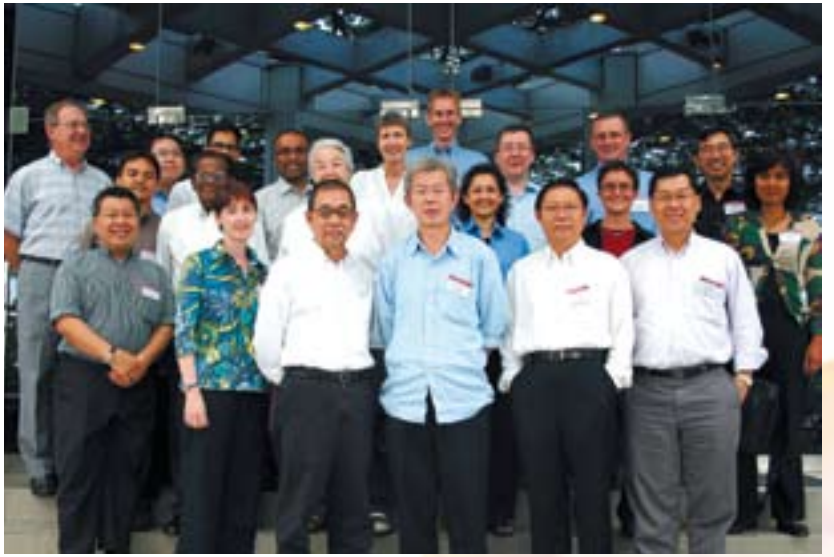
ASIALEX 2005 Singapore: Words in Asian Cultural Contexts (1–3 Jun 2005)

The 2005 biennial conference of the Asian Association for Lexicography (ASIALEX) was organised by the NUS **Department of English Language and Literature**, in conjunction with the **Faculty of Arts and Social Sciences** and the **Asia Research Institute** at NUS. The theme "Words in Asian Cultural Contexts" examined the functions and representations of words, and brought together scholars of language, linguistics and literature in an inter-disciplinary forum. Papers focused on a wider understanding of the word, including Asian contexts in which cultural and textual hybridity was the norm. Strands covered included: lexicology and lexicography; sociolinguistics and language pedagogy; information and communications technology; and literary, cultural and post-colonial studies.

Participants at the ASIALEX conference dinner.

Paths Not Taken: The False Spring of Political Pluralism in Post-war Singapore (14–15 Jul 2005)

Co-organised by the **Asia Research Institute** and Centre for Social Change Research, Queensland University of Technology, the symposium was the culmination of a 3-year project sponsored by the Australian Research Council. The event looked at political and social movements that have operated in post-war Singapore, in rivalry with the ruling party's hegemony. The abstracts addressed various aspects of these "alternative" histories, following the themes of "New Ideas", "Civil Society", "Chinese Social and Intellectual Movements" and "English-educated Movements".



Participants of the Paths Not Taken symposium. The event was organised by Prof Carl Trocki (last row, first left), Dr Michael Barr (last row, second right) and Prof Chua Beng Huat (front row, third left).

International Conference on Asia's Hou Hsiao-Hsien: Cinema, History and Culture (29–30 Apr 2005)

Despite the strong international presence of Asian cinema, the academic word of Asian cultural studies is lagging behind and the implications of such a global presence remain to be studied. This conference organised by the **Asia Research Institute** focused on one of the most important Asian film directors still working today – Hou Hsiao-Hsien. His cinema has been recognised globally as the representative figure of Asian cinema, and was chosen because of its strong connections beyond cinematic practices. The conference placed Hou's work in the intersection of cinema, culture, politics and history and brought together the best scholars working in the field of Asian film and cultural studies to trace his work and to locate Hou's contribution to Asian cultures and to world cinema.

International Conference on Naming in Asia: Local Identities and Global Change (23–24 Feb 2006)

The conference organised by the **Asia Research Institute** covered new ground to better understand the role of naming in Asian societies through their past history and present circumstances. The cross-cultural and cross-disciplinary study of personal names is one of the most promising endeavours in the fields of history, social anthropology, sociology and linguistics. It holds the key to a number of important issues, including the definition of personal identities, the position of the individual in society, religious and cosmological representations, social change, gender and history. In Asia, a great variety of personal naming systems exist, each influencing the way society defines personal and social identity. The colonial period and subsequent pressures of globalisation are reflected in various systems of naming, typically intended to combine some link with indigenous practice, ethnic identification, legibility to government and utility within a globalising system.

Papers presented explored the dynamics and structure of a particular naming system, the comparative study of personal names, the politics of naming, name-changing and religious conversion, structural role of naming and names in daily use.


RE: UNIVERSITY RESEARCH INSTITUTES & CENTRES 7

- Dynamic institutes focusing on key research areas
- Centres of cross-disciplinary competencies
- Emphasis on fields of strategic impact
- Examples of collaborative research partnerships

UNIVERSITY–LEVEL RESEARCH INSTITUTES & CENTRES

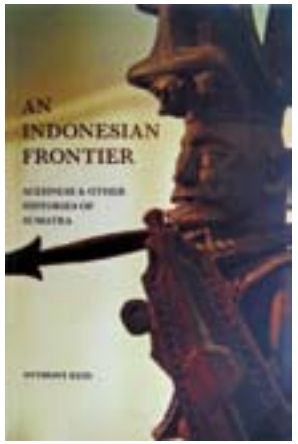
Asia Research Institute (ARI)

The Asia Research Institute (ARI) engages social sciences in a broadly defined manner, focusing on problem areas where collective efforts between and beyond disciplines will produce particularly useful interactions.

ARI's research clusters are organised around the following themes:

- Changing Family in Asia explores the dimensions of family change in the region, their causes and implications.
- Asian Migration focuses on the issues arising from increased human mobility in the region, both within and across national borders.
- Cultural Studies in Asia take a fresh look at existing knowledge to address new topics and concerns brought about by the rapid changes and impact on cultural practices, catalysed by technologies and globalisation.
- Religion and Globalisation in Asian Contexts examine the changing patterns of religious practice, belief and identity in recent times in Southeast Asia, China and South Asia.
- Southeast Asia–China Interactions revive the links between the region and China to understand the growing interdependencies and alliances.
- Asian Cities Project scrutinises cutting-edges areas of rapid change and the identity of Asian cities, particularly on the impact of rapid urbanisation, adapting and conserving heritage to a changing urban environment, and urban environmental planning.

The Institute also maintains an Open Cluster committed to enlisting new ideas and a wide diversity of perspectives.



To achieve diversity in perspectives, ARI brings together scholars from various backgrounds — arts and humanities, law, business, design and environment.

Centre for Maritime Studies (CMS)

Tan Sri Frank Tsao (left) and President Shih Choon Fong signing the MOU at the launch of CMS in June 2005.

The Centre for Maritime Studies (CMS) specialises in maritime affairs and undertakes research in areas relevant to the industry.

Issues critical to the maritime industry transcend traditional disciplinary boundaries, including economics, engineering, law, information technology, business and management, shipping and port policy, logistics, operations research, environment and maritime history.

Being a multi-disciplinary research centre at the University level, CMS provides a common platform for researchers from different disciplines to work together to embark on forward-looking research. One such avenue is the recently introduced Faculty Research Associates Programme (FRA) that encourages and facilitates cross-faculty maritime research.

CMS also offers continuing maritime education and training through workshops and executive programmes; and consultancy services on specific matters on demand.

Researcher at CRISP facility working on remote sensing images.

Centre for Remote Imaging, Sensing and Processing (CRISP)

The Centre for Remote Imaging, Sensing and Processing (CRISP) has been actively developing an advanced capability in remote sensing to meet the scientific, operational and business requirements of Singapore and the region. Its research focuses on the processing and application of very high spatial resolution imagery, hyperspectral data with tens to hundreds of spectral bands, and multiple polarisation synthetic aperture radar. Emphasis is placed on developing applications for remote sensing monitoring of the regional environment as well as designing techniques in feature extractions for 3-D visualisation of satellite data.

In environmental monitoring, CRISP plays a major role in helping to capture intelligence on regional forest fire detection and retrieving coastal sea water quality parameters from remote sensing data. It initiated applications of remote sensing data in disaster monitoring and management in response to the December 2004 Indian Ocean tsunami. In the aftermath of the tsunami, timely satellite images of the tsunami affected areas were supplied to the Singapore rescue team to help in their mission planning and execution.

Institute for Mathematical Sciences (IMS)

The Institute for Mathematical Sciences (IMS) fosters multi-disciplinary research that links mathematics to other disciplines, nurtures the growth of mathematical expertise among research scientists, and trains talent for research in mathematical sciences. By serving as a platform for the dissemination of the most recent developments and the training of young mathematical scientists, IMS provides a forum for the exchange of ideas that will generate new perspectives on important mathematical and scientific problems.

IMS facility at Prince George's Park.

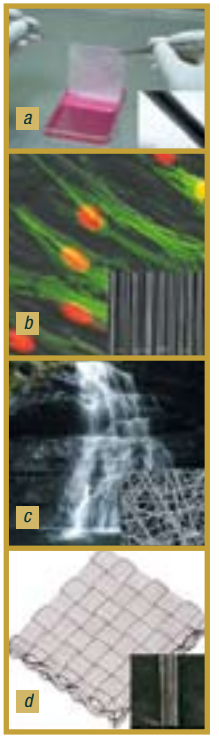
The Institute organises thematic programmes that bring together local and overseas mathematicians and scientists from a broad spectrum of disciplines. IMS also organises outreach activities in the form of public lectures, school lectures and maths camps conducted by international visiting scientists. In addition, it produces *Lecture Notes Series* on selected lectures delivered at the Institute.

NUS Nanoscience and Nanotechnology Initiative (NUSNNI)

NUS Nanoscience and Nanotechnology Initiative (NUSNNI) taps the collective knowledge of researchers in Engineering, Medicine and Science to initiate and coordinate long-term nanoscience and engineering research. The Initiative aims to achieve fundamental discoveries of novel phenomena, processes and tools and seeks to educate and train multi-disciplinary nanoscientists and nanoengineers for academia, industry and public service.

Its approach to the development and promotion of nanotechnological efforts is to optimise resources in creating strategic high-impact research while retaining the diversity of the multiple disciplines. The nanoscience and nanotechnology platform will build on the strengths of the faculties and focus on strategic programmes to excel in special niches. Several core areas have been identified from the University's existing research: nanofibre science and engineering, nanophotonics, nano/microfabrication, nanobiotechnology and nanomagnetics and spintronics.

Researchers at NUSNNI have made breakthroughs and achieved some world's firsts in nanophotonics, nanofabrication and nanomaterials.



Science, technology and application of nanofibres and nanofibrous membranes: (a) drug delivery; (b) tissue engineering; (c) water treatment; and (d) protective fibres.

Risk Management Institute (RMI)

The Risk Management Institute (RMI) was set up in 2006 to be a world-class centre in financial risk management. A partnership with University of California at Berkeley and supported by the Monetary Authority of Singapore, the Institute evolves from the NUS Centre for Financial Engineering founded in 1997.

Through research, education and training, RMI seeks to create the capacity to train high-calibre finance professionals in Singapore, and generate strong multi-disciplinary research programmes spanning basic and applied research relevant to industry, government and society. Together with RMI members, industry practitioners and visiting faculty, staff from the NUS Business School, Department of Mathematics, Department of Economics and others will develop high-quality research and education programmes in risk management. Subjects covered include financial risk management; mathematical and statistical modelling of financial and derivative securities; as well as measurement, modelling, analyses and regulation of economic risks in the financial and banking sectors. Specific emphasis will be placed on financial, economic and risk and management issues pertinent to the Asia context.

Singapore Synchrotron Light Source (SSLS)

The Singapore Synchrotron Light Source (SSLS) seeks to open up the world of leading-edge synchrotron radiation methods to Singapore's science, education, technology, industry and commerce. By providing synchrotron radiation service for scientific and technological applications, it aims to attract and enable industry to conduct advanced research and manufacturing in Singapore. In addition to performing its own R&D in synchrotron radiation applications and developing advanced synchrotron radiation sources, SSLS also provides synchrotron radiation service for commercial applications.

SSLS has expanded its scope of activities to include R&D programme featuring micro/nanofabrication, a variety of analytical applications, and the development of advanced synchrotron radiation instrumentation. Micro/nanofabrication by means of X-ray lithography and the LIGA process is focused on Terahertz, near-infrared and X-ray microoptics devices, nanofilters and nanosensors. Analytical applications include surface, interface and nanostructure studies, catalyst development, speciation of elements for environmental and materials science, characterisation of molecules on surfaces and in the gas phase, and the imaging of biological and technological systems.

Prof Herbert O Moser (right) and PhD candidate Mr B D F Casse at the infrared microscope of the ISMI beamline at SSLS.

Region-of-Interest image compression developed at TL@NUS.

Temasek Laboratories@NUS (TL@NUS)

Temasek Laboratories@NUS (TL@NUS) was set up as a "third pillar" of national defence technology infrastructure to complement DSO National Laboratories and the local defence industry in harnessing the potential of science and technology to enhance Singapore's security and defence. With emphasis on basic, upstream research on strategic topics of national interest, it serves as a link between NUS and Singapore's defence science research communities. Besides working with local researchers, it also undertakes collaboration with overseas institutions. Training research scientists and engineers to conduct advanced defence R&D is another important aspect to building up talent and strength for the future.

Research focuses at TL@NUS encompass aeronautics, control and guidance, electromagnetics, signal processing and information security. Cutting-edge pioneering work at the lab has produced encouraging results with real relevance for the defence sector.

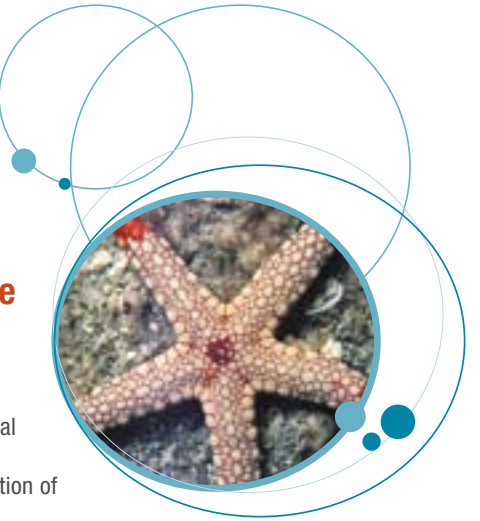
The Logistics Institute – Asia Pacific (TLI – Asia Pacific)

The Logistics Institute – Asia Pacific (TLI – Asia Pacific), a collaboration between NUS and the Georgia Institute of Technology, is poised to be the premier institute in Asia Pacific for nurturing logistics excellence in research and education. The Institute is committed to providing joint logistics expertise that caters to the needs of industries worldwide by focusing on global logistics, information technology, industrial engineering and supply chain management. Its strong links with the Faculties of Engineering, Science, Computing and Business in NUS makes for a unique blend of disciplines necessary for the advancement of logistics practice.

The Institute has identified three strategic research thrusts: supply chain optimisation to deepen expertise in supply chain global network design and optimisation; supply chain technology such as radio frequency identification and data capture-related technologies; and, supply chain intelligence to provide analysis of logistics market, trade flows and economic barometer of various countries in Asia.

TLI – Asia Pacific also organises training programmes for upgrading human resources and helping with innovative logistics solutions using emerging technologies.

TLI – Asia Pacific supply-chain optimisation models have great potential as decision-support tools for strategic and operational planning of chemical companies.



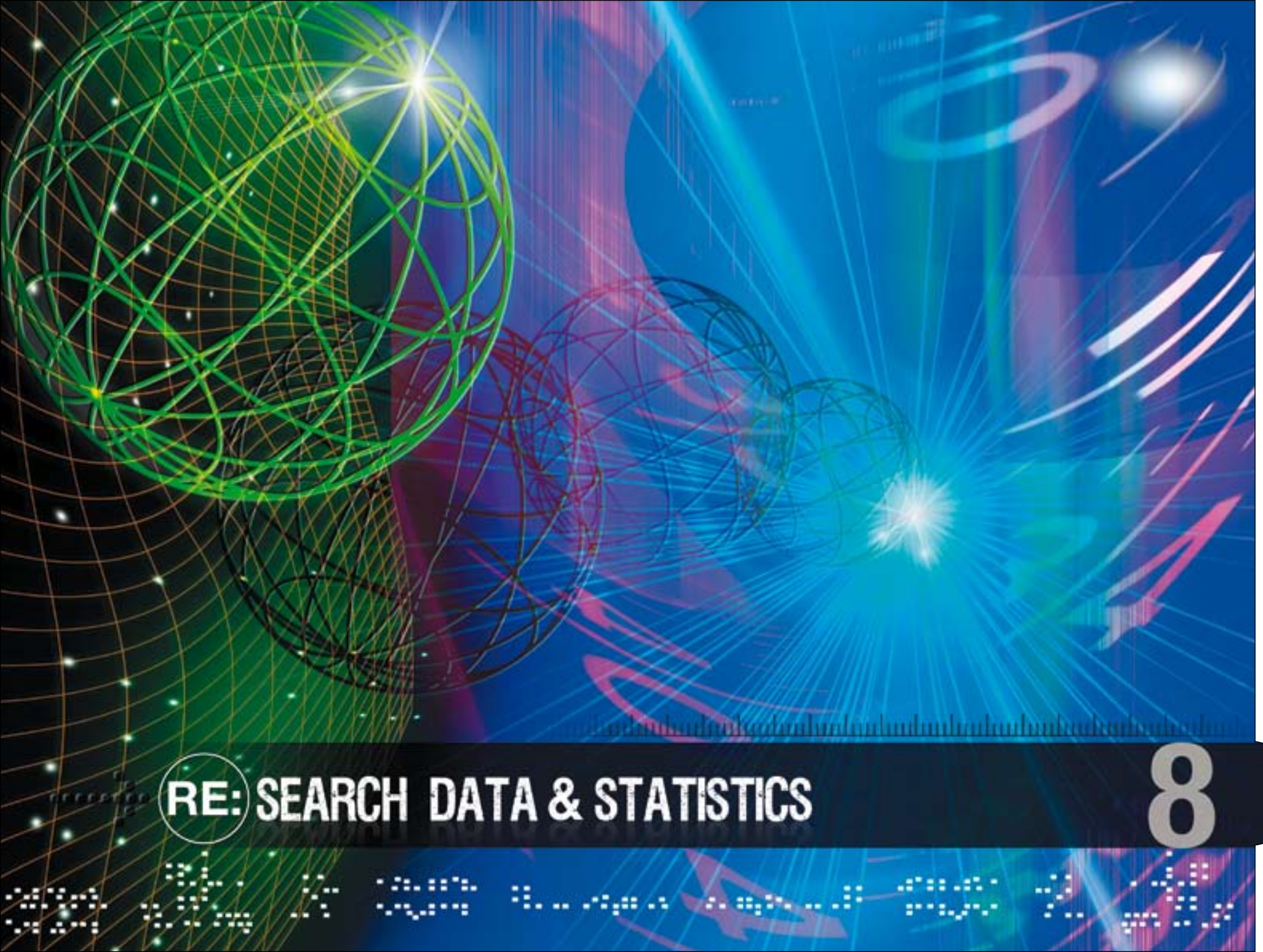
Tropical Marine Science Institute (TMSI)

The Tropical Marine Science Institute (TMSI) was established as a national resource centre in tropical marine science to place Singapore in a strategic position to derive economic benefits from exploitation of the resultant technologies.

The Institute has multi-disciplinary research laboratories and conducts research programmes with applications that include policy, environmental and crisis management, primary production and environmental forecasting. It believes in the strength of cross-disciplinary interaction to enhance productivity and application. Many of the research projects benefit from pooling the skills of scientists and engineers with diverse backgrounds, locally and internationally.

Key areas of research include underwater acoustics, marine biology, physical oceanography, aquaculture, marine environment and marine mammal. A new programme to develop a fleet of autonomous underwater vehicles has recently been started in collaboration with the Faculty of Engineering. The Physical Oceanography Research Laboratory has developed several long-term research and application programmes with various national government bodies and private companies. It also forges international collaboration with Massachusetts Institute of Technology, Cornell University, Delft Hydraulics and other organisations to look at areas such as coastal water mixing, integrated water resources, and environmental impacts that have global implications.

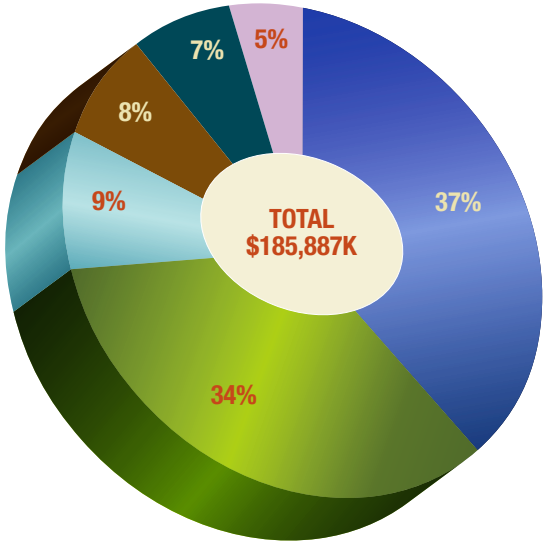
TMSI provides research and teaching opportunities in marine science and aims to be a regional/international training centre for tropical marine science.


RE: SEARCH DATA & STATISTICS
8

- Expanding base of research projects and scope
- Increasing funding indication of research relevance
- Strengthening research manpower
- Growing number of quality publications
- More novel outcomes translated into patents

RESEARCH FUNDING — BY SOURCE (FY 2005)

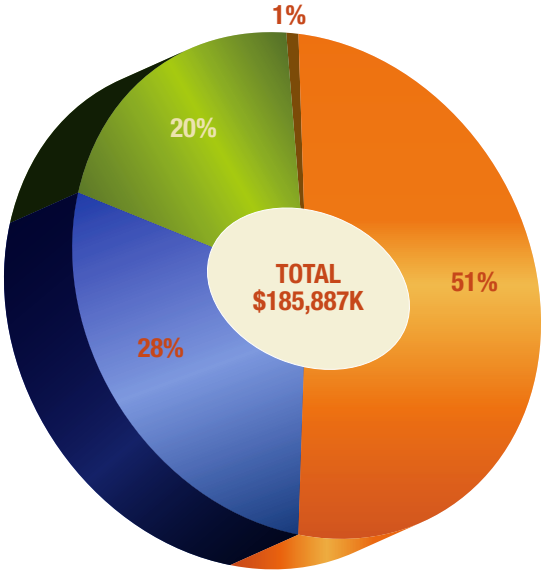
(Source: Office of Finance)



- Ministry of Education (MOE) **$70,163K**
- Agency for Science, Technology & Research (A*STAR) **$62,296K**
- Other Ministries/ Statutory Boards **$17,390K**
- Ministry of Health (MOH) **$13,947K**
- Industry/ Foundations/ Individuals and Others **$12,392K**
- Singapore Totalisator Board **$9,699K**

RESEARCH FUNDING — BY TYPE (FY 2005)

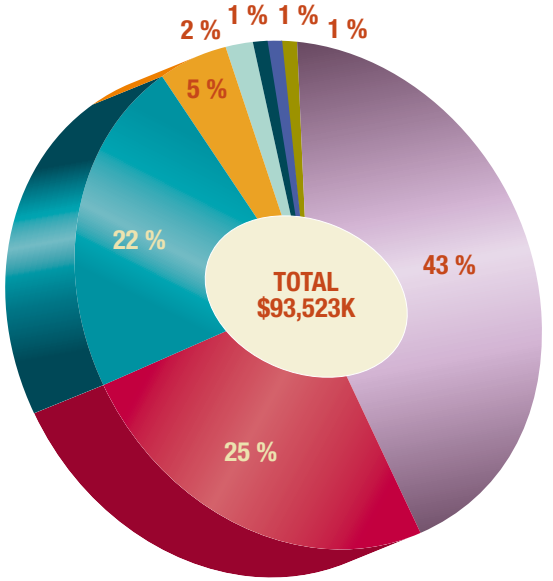
(Source: Office of Finance)



- Faculties & Schools **$93,523K**
- Research Scholarships **$52,811K**
- University RICs **$38,054K**
- Research Programmes **$1,499K**

RESEARCH FUNDING — BY FACULTIES & SCHOOLS (FY 2005)

(Source: Office of Finance)



- Medicine **$40,455K**
- Engineering **$23,055K**
- Science **$20,624K**
- Computing **$4,498K**
- Dentistry **$1,552K**
- Design & Environment **$1,266K**
- Arts & Social Sciences **$1,256K**
- Others **$817K**

Note:

FY 1997 – FY 1999

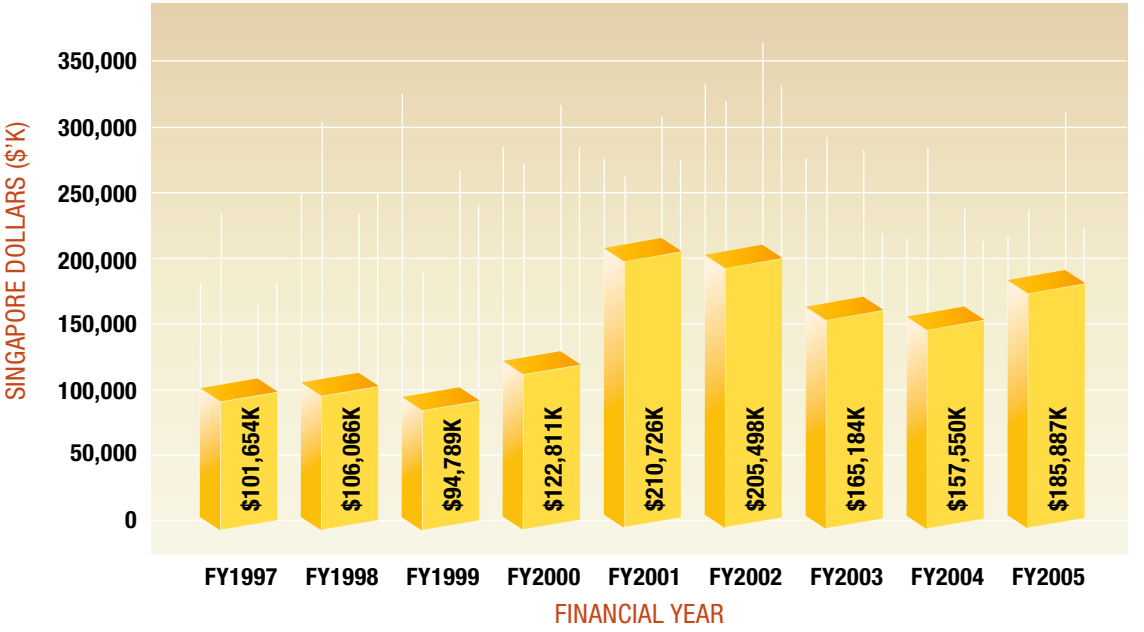
- *Figures exclude funding for RICs and Research Programmes.*
- *Ministry of Education figures are based on approved budgets for approved projects.*

FY 2000 – FY 2005

- *Ministry of Education and Singapore Totalisator Board figures are based on actual expenditure.*
- *Figures include funding for NUS Faculties, Schools, Research Scholarships, Reseach Programmes and University RICs.*

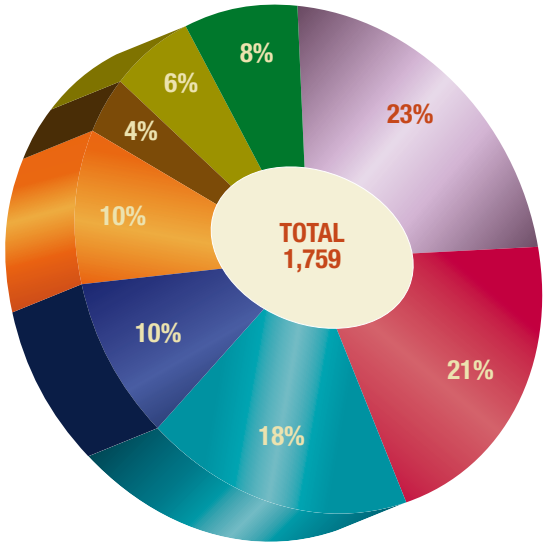
RESEARCH FUNDING — PROFILE (FY 1997 – FY 2005)

(Source: Office of Finance)



NUMBER OF RESEARCH PROJECTS FUNDED — BY FACULTIES/ SCHOOLS/ RICS (FY 2005)

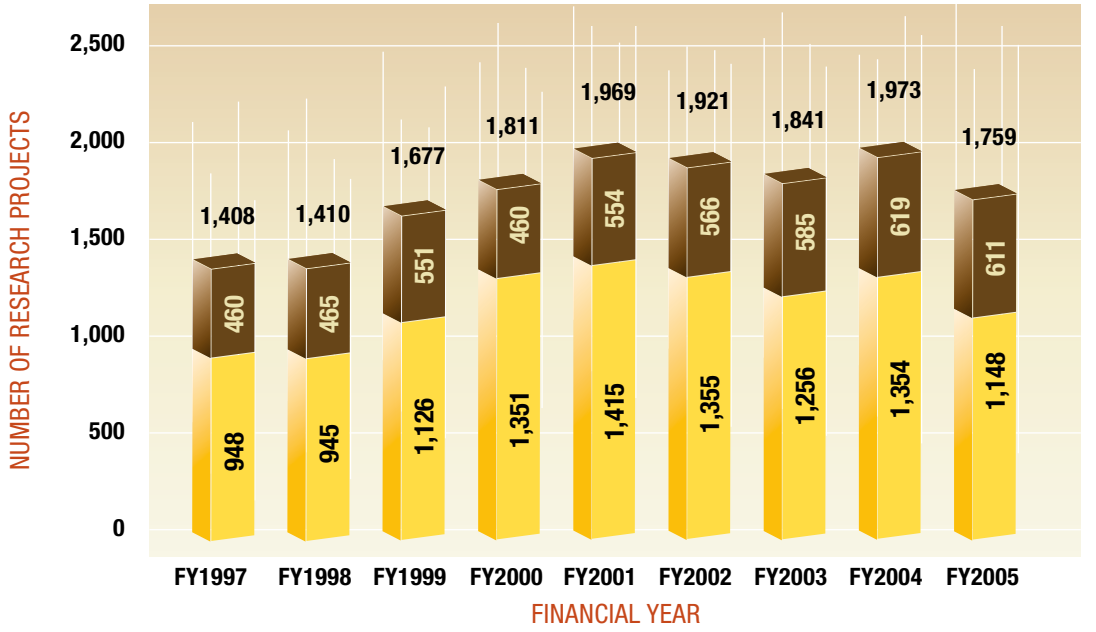
(Source: Office of Finance)



- Medicine **402**
- Engineering **378**
- Science **314**
- Arts & Social Sciences **175**
- Computing **169**
- Business **66**
- Other Faculties/ Schools **107**
- University RICs **148**

NUMBER OF RESEARCH PROJECTS FUNDED — PROFILE (FY 1997 – FY 2005)

(Source: Office of Finance)

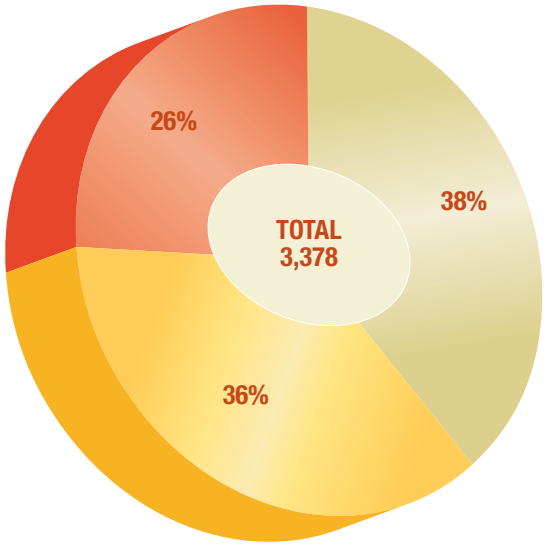


Note:

- *New projects refer to projects that started during the FY.*
- *The research projects of Research Institutes & Centres (RICs) include those projects funded by RIC's own operating budget. For the Faculties & Schools, research projects are funded by Academic Research Fund (ARF), grants from Ministries, Statutory Boards, Foundations, Industries and other sources.*

STAFF HEADCOUNT* (AS AT MARCH 2006)

(Source: Office of Human Resources)

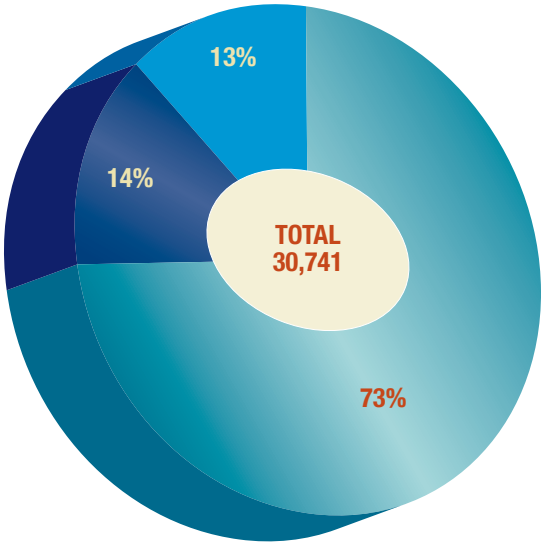


- Tenurable Faculty **1,268**
- Research Staff **1,222**
- Other Teaching Staff **888**

* *Tenurable, Other Teaching and Research Staff for Faculties, Schools and University RICs.*

STUDENTS STRENGTH — BY TYPE (2005)

(Source: Registrar's Office)



- Undergraduate Students **22,510**
- Graduate Students by Research **4,330**
- Graduate Students by Coursework **3,901**

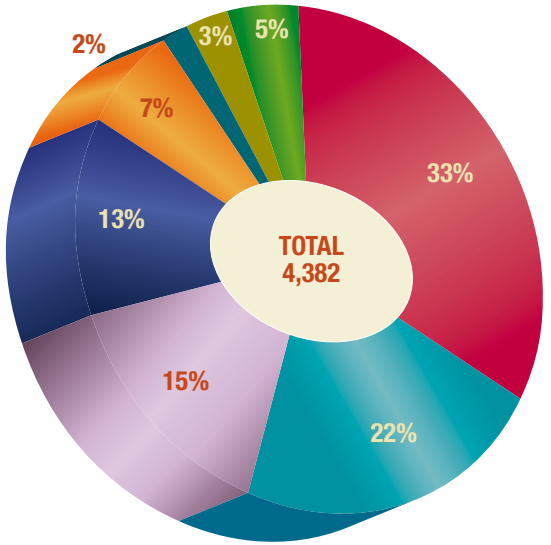
Note:

– *Graduate Student figures for FY 2005 as at 10 Feb 2006.*

– *Undergraduate Student figures as at 21 Feb 2006.*

RESEARCH GRADUATE STUDENTS STRENGTH — BY FACULTIES/ SCHOOLS/ RICS (FY 2005*)

(Source: Registrar's Office)



- Engineering **1,457**
- Sciences **963**
- Medicine **632**
- Arts & Social Sciences **559**
- Computing **309**
- Design & Environment **104**
- Other Faculties/ Schools **150**
- Others **208**

* *Figures as at 30 Aug 2006.*

RESEARCH GRADUATE STUDENTS STRENGTH — PROFILE (FY 1997 – FY 2005)

(Source: Registrar's Office)

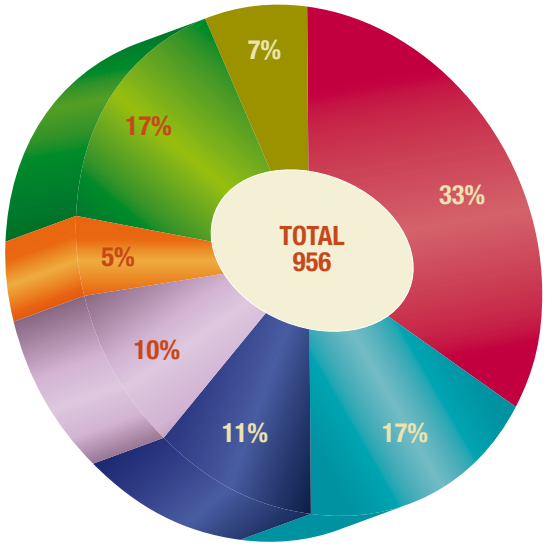
Note:

Includes students who have withdrawn/ terminated/ graduated during the specific period. The enrolment trend of Masters and PhD students has shifted in recent years, with more students enrolling into PhD studies.

* *Figures as at 30 Aug 2006.*

RESEARCH GRADUATE STUDENTS GRADUATED* (FY 2005)

(Source: Registrar's Office)



- Engineering **309**
- Sciences **161**
- Arts & Social Sciences **108**
- Medicine **97**
- Computing **50**
- RICs** **167**
- Other Faculties/ Schools **64**

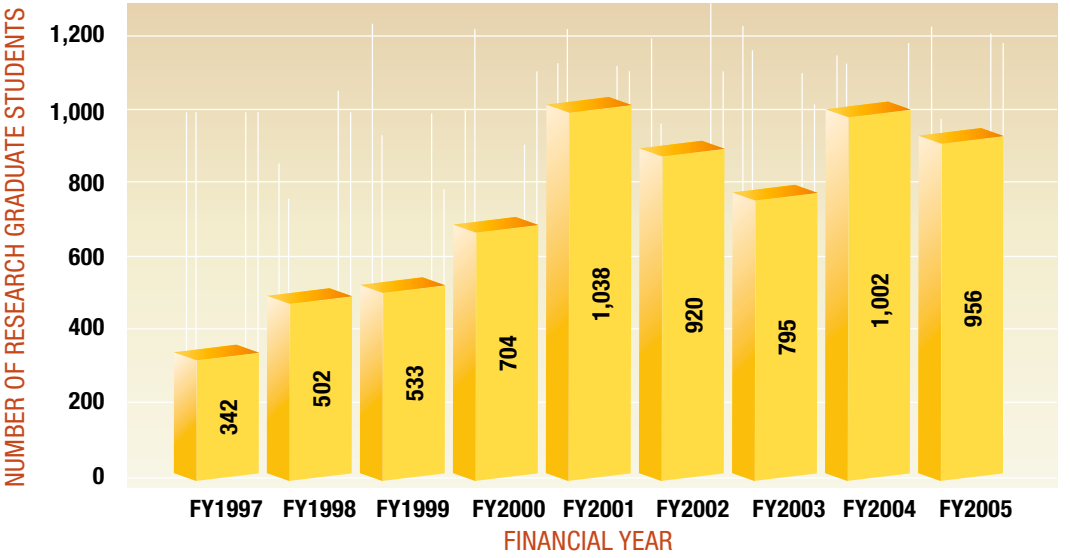
Note:

* *Figures are based on students' conferred dates between 1 Apr 2004 – 31 Mar 2005.*

** *Includes NUS-affiliated RICs: IMRE, IMCB, I²R, IHPC, IMA, ICES, IBN, BII.*

RESEARCH GRADUATE STUDENTS GRADUATED — PROFILE (FY 1997 – FY 2005)

(Source: Registrar's Office)

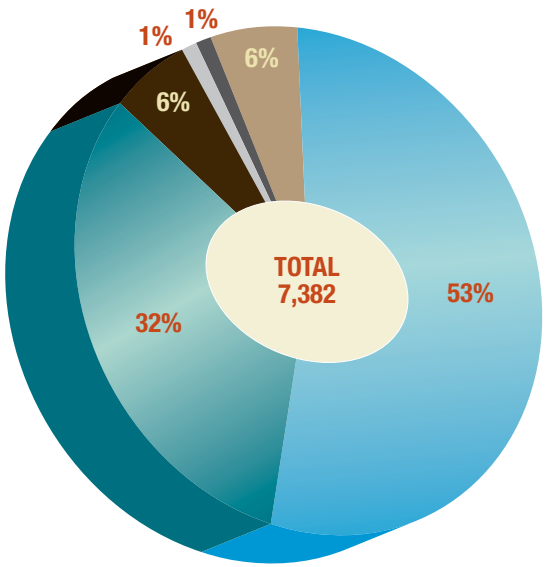


Note:

The number of graduates has declined in recent years because more students enrolled or upgraded to PhD studies.

RESEARCH PUBLICATIONS — BY TYPE (CY 2005)

(Source: Office of Research)



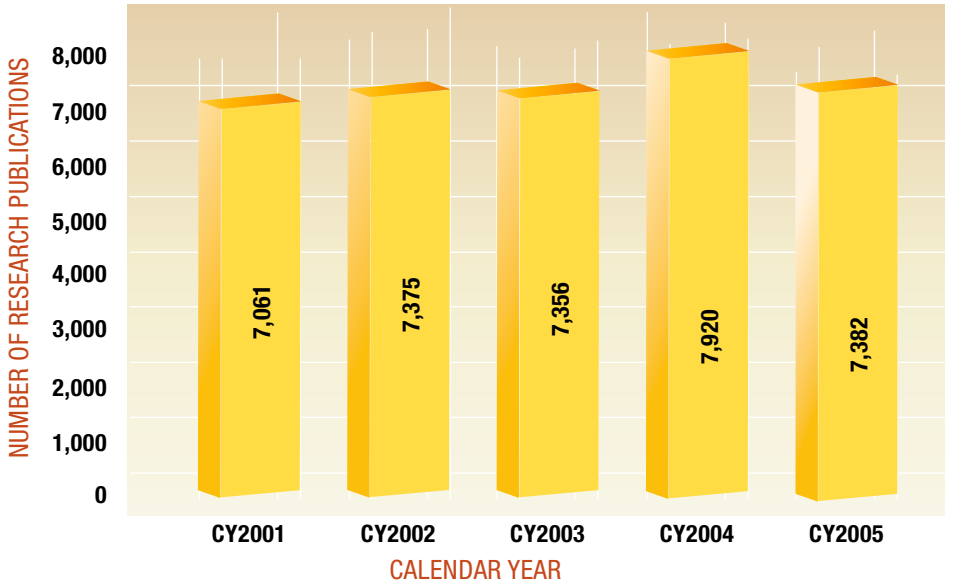
- Articles in Refereed Journals **3,927**
- Conference Papers **2,334**
- Chapters in Books **469**
- Books/ Monographs Authored **104**
- Books Edited **78**
- Others **470**

Note:

Figures true as at 26 Nov 2006.

RESEARCH PUBLICATIONS — PROFILE (CY 2001 – CY 2005)

(Source: Office of Research)

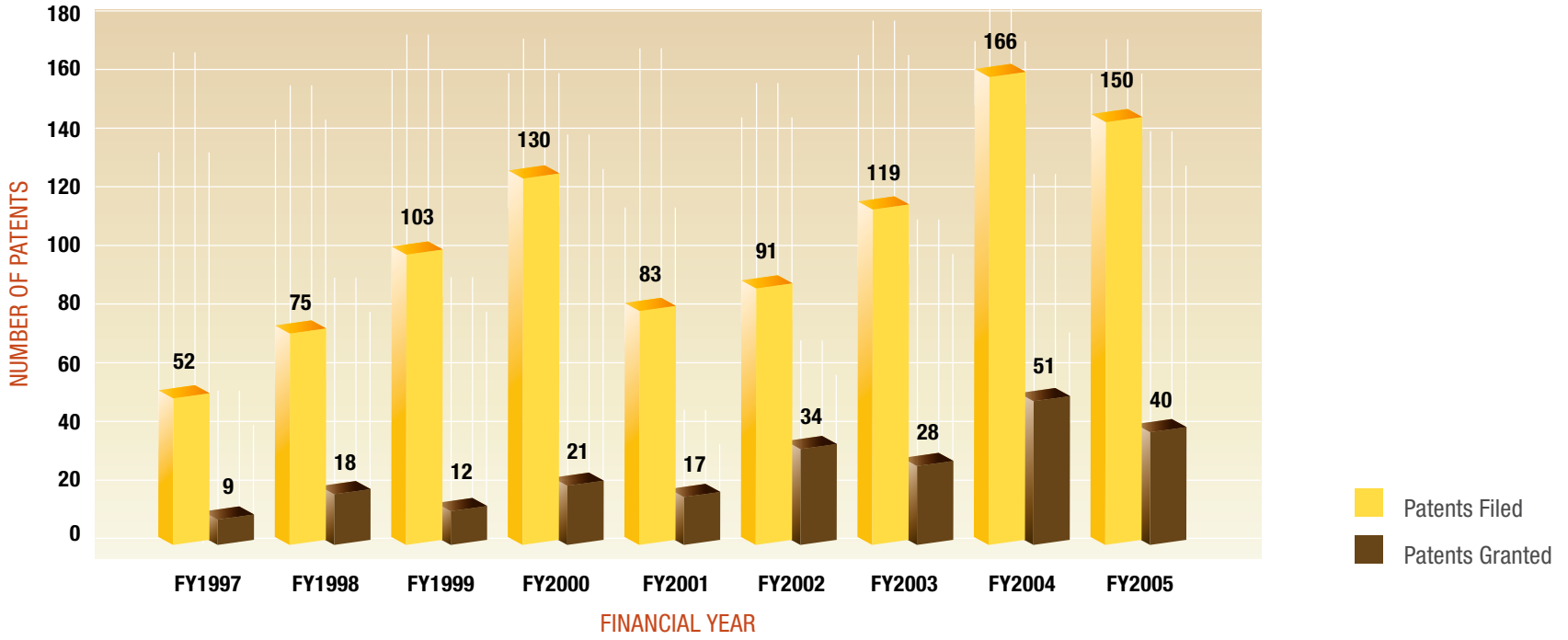


Note:

Figures for CY 2005 true as at 26 Nov 2006.

PATENTS FILED & GRANTED — PROFILE (FY 1997 – FY 2005)

(Source: Industry Liaison Office)



RE: SEARCH CONTACTS

9

RESEARCH CONTACTS

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- Prof Chew Yong Tian — Deputy Director
- Prof Heng Chye Kiang — Deputy Director
- Prof Lim Hock — Deputy Director
- Dr Chong Wai Keong — Senior Asst Director

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- Prof Hew Choy Leong — Director
- Assoc Prof Lim Chwee Teck — Deputy Director
- Prof Ong Choon Nam — Deputy Director

faculties & schools

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- Assoc Prof Chua Fook Kee — Vice Dean (Research)

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- Prof Christopher Earley — Dean
- Prof Rajiv Surendra — Asst Dean (Research)

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Tel: (65) 6516 2727 Fax: (65) 6779 4580

Website: www.comp.nus.edu.sg

- Prof Joxan Jaffar — Dean
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